POWER

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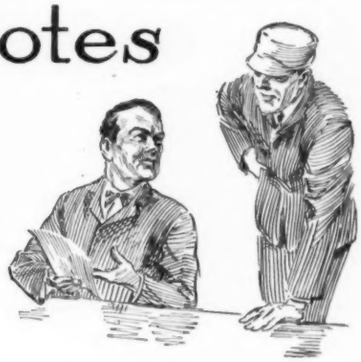
Purposeful Anecdotes

Have You Provided for Breakdowns?



IN A CERTAIN power plant there was a chief engineer who knew all the "ins and outs" of machinery. He was skillful in making repairs; steady and conscientious about his work; and his operating costs were low.

Naturally so valuable a chief was held in high esteem by his employers, but with his men he was not popular. The reason was not far to seek. He was of the opinion that the best way to cinch his job was to keep all his men as ignorant as possible in all matters not pertaining directly to their own narrow fields of work. By acquiring a "corner" in the "knowledge market" about his plant, he thought he could discourage all would-be usurpers of his job. The result was that no really ambitious man ever stayed long with him, and the plant became virtually a one-man concern.

Finally a day of reckoning came. The chief was stricken with typhoid and there was nobody at hand competent to take his place. The management was obliged to summon a new chief post haste from another city under promise of a high salary and steady work.

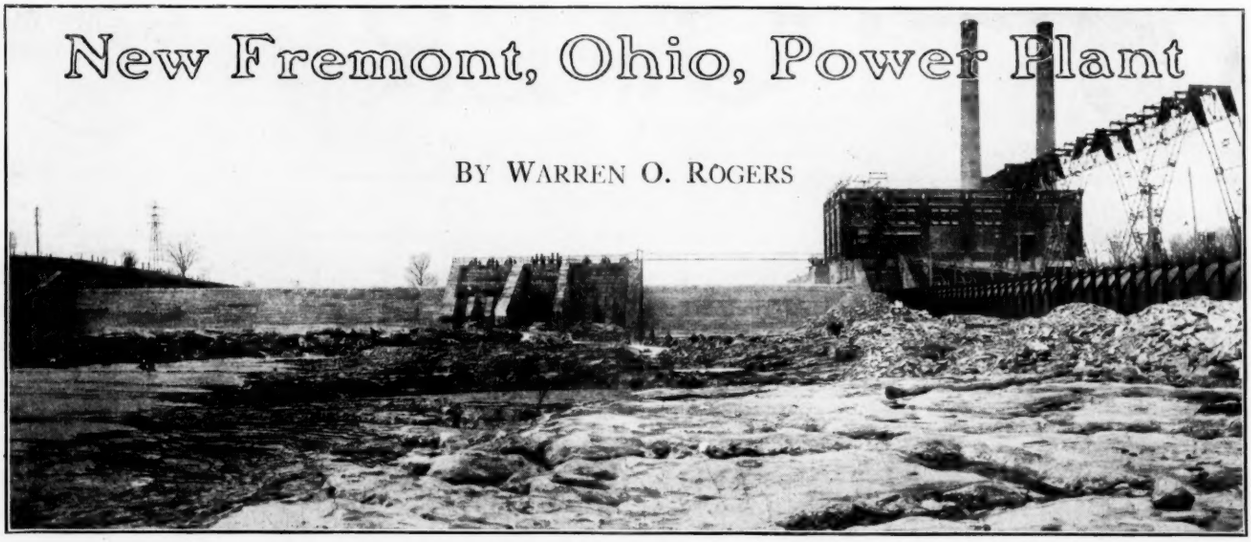
The new chief was not superior to the old one so far as knowledge and skill were concerned, but he had foresight. He began at once to take interest in his force. He stimulated their desire to learn; encouraged them to ask questions about the plant; and soon had one or two of them trained so that they were capable of handling his work temporarily if necessary. This not only relieved him somewhat, but greatly benefited them. The men gained in self-respect, efficiency and loyalty to their employers. The improved conditions were soon reflected in decreased operating costs. The management was not slow to notice the improvement, and the new chief's stock rose rapidly.

Finally the old chief was able to be about, and the manager called him into his private office for a heart to heart talk. "We have no fault to find with your qualifications," said the manager, "and we appreciate your past services; but by failing to train your assistants, you placed us in a very precarious situation. We do not, therefore, feel in duty bound to take care of you, especially since your absence occasioned us heavy expense and your successor is excelling your record. We will gladly recommend your ability to any employer, but take my advice, even if you are to be the chief prime mover, provide for breakdown service."

Contributed by WILLIAM A. DUNKLEY, *Atlantic City, N. J.*

New Fremont, Ohio, Power Plant

By Warren O. Rogers



SYNOPSIS—A working pressure of 250 lb. of steam, superheated 125 deg., is carried on the boilers. The main turbines are provided with a vacuum-controlled throttling valve. If the vacuum drops below a predetermined point, about 8 in., steam is cut off from the turbine, thus preventing damaging the condensing units, there being no atmospheric exhaust pipe. The turbines driving the boiler-feed pumps and the air and circulating-water pumps for the condensers are of a new design and operate with a steam consumption of less than 30 lb. per b.hp. The piping system is different from that found in the general design of power plants.

The new power plant of the Ohio State Power Co., near Fremont, Ohio, is practically completed. The station, which is located on the Sandusky River, works in conjunction with a hydro-electric plant operated by the same company about one-half mile downstream.

In the turbine room there are three 6,250-kv.-a. 4,000-volt turbo-generators, with direct-connected 125-volt exciters. A partial view of the turbine room is shown in Fig. 1. The steam pressure carried is 250 lb., superheated 125 deg. One of the several interesting features of the plant is that of operating the main turbines without providing an atmospheric exhaust in case the vacuum should be lost. The turbines and condensers are protected against excessive steam pressure in case of the vacuum falling below about 8 in., by a specially designed balanced valve automatically controlled by the vacuum in the discharge outlet of the turbine. The operation of the valve is simple—the vacuum acting against the pressure of a spring. The vacuum acting on a diaphragm holds the valve open while the turbine is running; the spring holds the valve closed when the turbine is not running or in case the vacuum falls below that necessary to hold the valve open. In order to start the turbine, the condenser air pump must be got up to speed so as to create a vacuum sufficient to open the automatic valve. If the vacuum is lost, the valve immediately stops the flow of steam to the turbine.

It is estimated that two of the turbines will carry the present load, leaving one unit as a stand-by. When the station load increases sufficiently to require the running of the third unit, a fourth one will be installed, so that there will always be an extra machine available in case one of the others requires repairs. In following out this plan, an uninterrupted service can be depended upon, unless a serious accident should happen to the boilers or to the main steam piping.

All generators are cooled by taking air from outside the building and bringing it in through a screen to the storage-battery room, near the ceiling of which are ducts leading to the generator. This arrangement will keep the temperature of the battery room low and the air constantly changing.

These turbines are supported by I-beams run lengthwise of the machine, and they in turn are supported by structural ironwork at the ends. By this arrangement no concrete foundations are required and the basement is left free for the condensing apparatus. The method of supporting the turbines is shown in Figs. 5 and 6. A 25-ton motor-operated crane spans the turbine room.

In the basement the condensing outfit consists of three surface condensers, each containing 7,000 sq.ft. of copper-tubing cooling surface. This gives 1.4 sq.ft. per kw. output of the turbine. The condensers are carried by four steel columns, Figs. 5 and 6. The turbine discharge is 20 in. diameter. The 20-in. circulating-pump suction extends below the basement floor to a 3x5-ft. intake duct that takes water from above the dam. All pipes handling condensing water are made with welded elbows.

Both the 18-in. circulating-water and the turbo air-circulating pumps are driven by steam turbine. The turbine runs at 7,500 r.p.m., but the speed of the pumps is reduced by helical gears to 1,500 r.p.m. One of the condenser units is shown in Fig. 2.

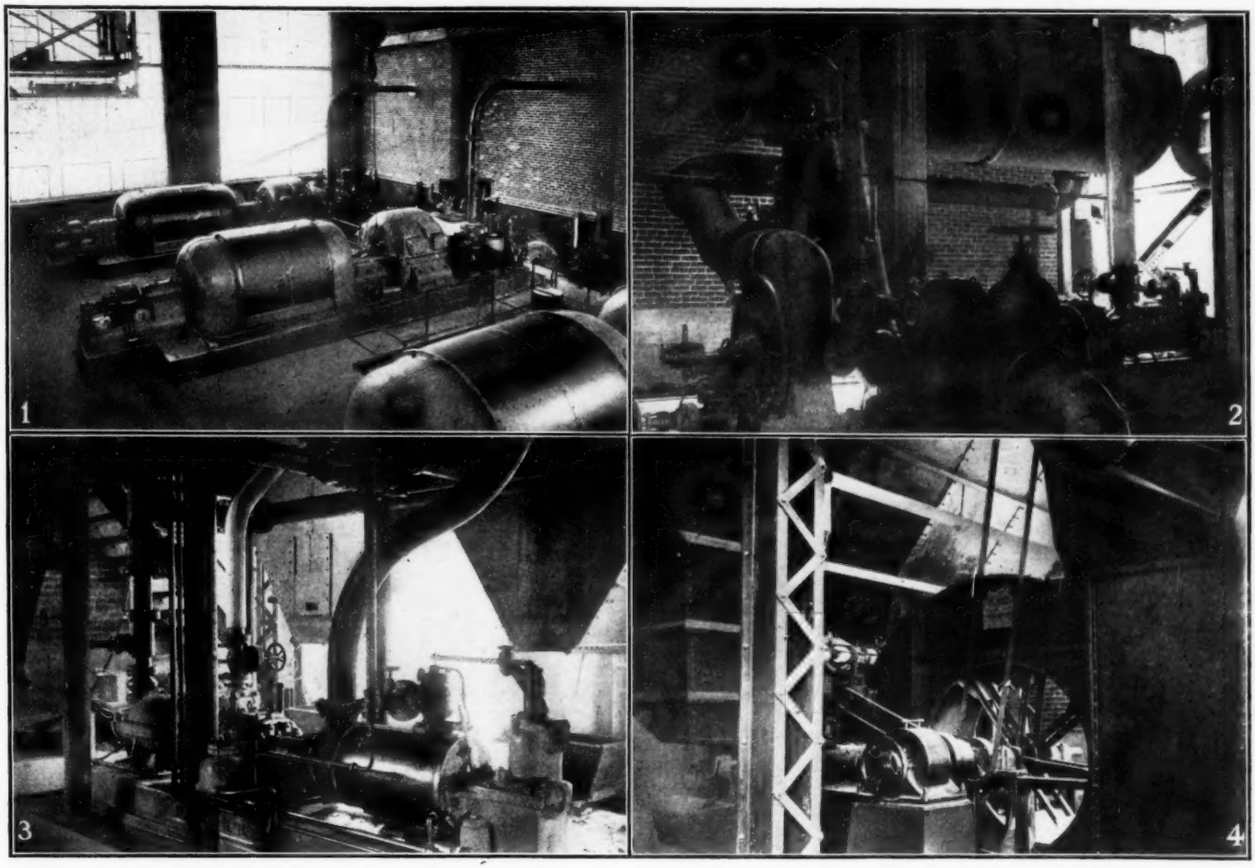
The condenser turbines are of the reaction type and are believed to be the first of their kind built in this country. Each is designed to operate with the high pressure of 250 lb. (gage) superheated 125 deg. F. at the throttle and with a back pressure not exceeding 18 lb. absolute at the exhaust nozzle. With the foregoing conditions, these turbines are guaranteed to operate with a steam consumption not exceeding 29.8 lb. of dry steam per brake horsepower at full-capacity rating and a steady load.

Flood lubrication is applied to the turbine bearings, the oil being supplied by a pump operated from an ex-

tension on the governor spindle. The reduction gears are lubricated by oil from a small gear-driven pump attached to one end of the gear casing.

In the forebay, the water level reaches a point just below the center line of the condensers. The circulating pump is below this level so that it is always supplied with water. As both legs of the piping are nearly balanced and as there is some syphonic action the work of the pump is reduced.

Each air-circulating pump is provided with a 1-in. steam-jet primer, and the 6-in. hurling water-suction and 8-in. hurling water-discharge pipes extend from



FIGS. 1 TO 4. VIEWS OF THE FREMONT, OHIO, POWER PLANT

Fig. 1—A view of the three turbine units. Fig. 2—One of the condenser sets. Fig. 3—Turbine-driven boiler feed pump. Fig. 4—Forced-draft fan set

and to a concrete well below the pump. From these wells three motor-driven house-service pumps obtain raw water for the soft-water filters and for hose connections. These pumps discharge into a raw-water pipe that runs to the water softener in the boiler-room basement. The softener has a capacity of 2,000 gal. per hour.

The firing floor of the boiler room is on a level with that of the turbine room. The four water-tube boilers, each containing 7,629 sq.ft. of heating surface, are placed two on each side of a firing aisle, Fig. 7. These boilers carry a working pressure of 250 lb. and 125 deg. superheat, and other than being constructed of heavier material than the standard design, there is nothing special or unusual about the boilers. They are built according to the latest A. S. M. E. Code.

Each boiler furnace is equipped with a four-retort underfeed stoker, each retort capable of burning 2,500 lb. of coal per hour. The furnaces are each 8 ft. deep and 16 ft. wide, giving a furnace area of approximately one square foot to sixty square feet of boiler-heating surface.

An improvement has been incorporated in the general design of these stokers in that an automatic self-cleaning clinker attachment has been applied. It consists of a revolving ash grate operated by a ratchet the speed of which is adjustable so that any desirable regulation can be made to the movement of the cleaning device. Ashes fall from the grates into pits in the basement, and are then discharged into industrial cars and conveyed to an ash bin outside the building. From this bin they are taken by the same clamshell bucket that handles the coal and loaded into cars for removal.

Above the center aisle of the boiler room is a 90-ton capacity coal bunker from which spouts drop to the stoker hoppers. Outside of the power house is a 2,000-ton storage basin in which coal is stored when received in large quantities or when it is to be held as a reserve supply. The loaded coal cars are run on a trestle built across the center of the storage basin. Coal is conveyed from the storage bin to the bunker in the boiler house by a monorail system (see illustration at head of this article). The bucket is of 1½-cu.yd. capacity and it requires two minutes to make a round trip.

Two concrete tapered stacks reaching to a height of 140 ft. above the grates serve the four boilers. Each has an inside diameter at the top of 8 ft. 6 in.

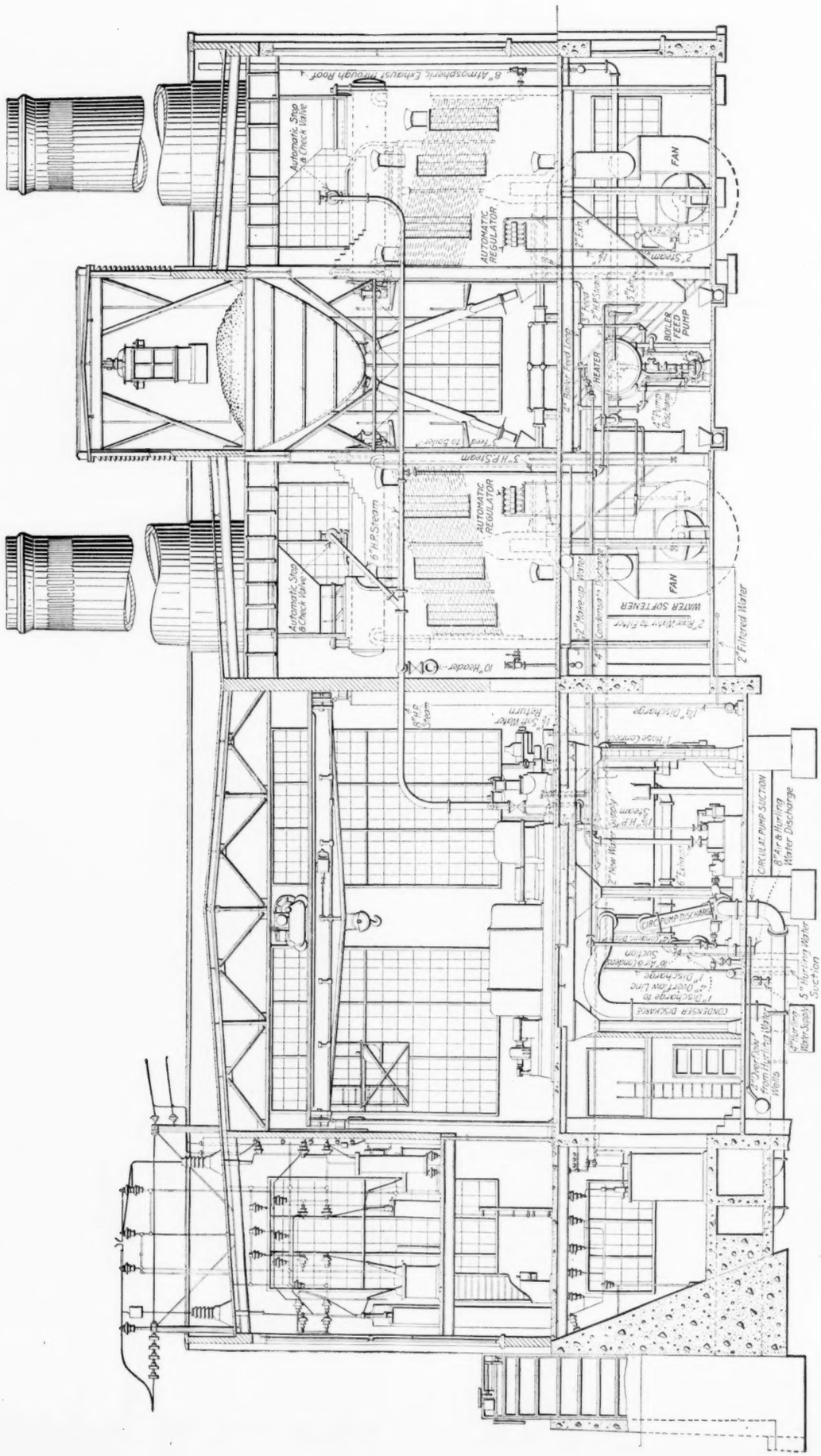


FIG. 5. LONGITUDINAL SECTION THROUGH PLANT, SHOWING SWITCH GALLERY, TURBINE ROOM AND BOILER ROOM

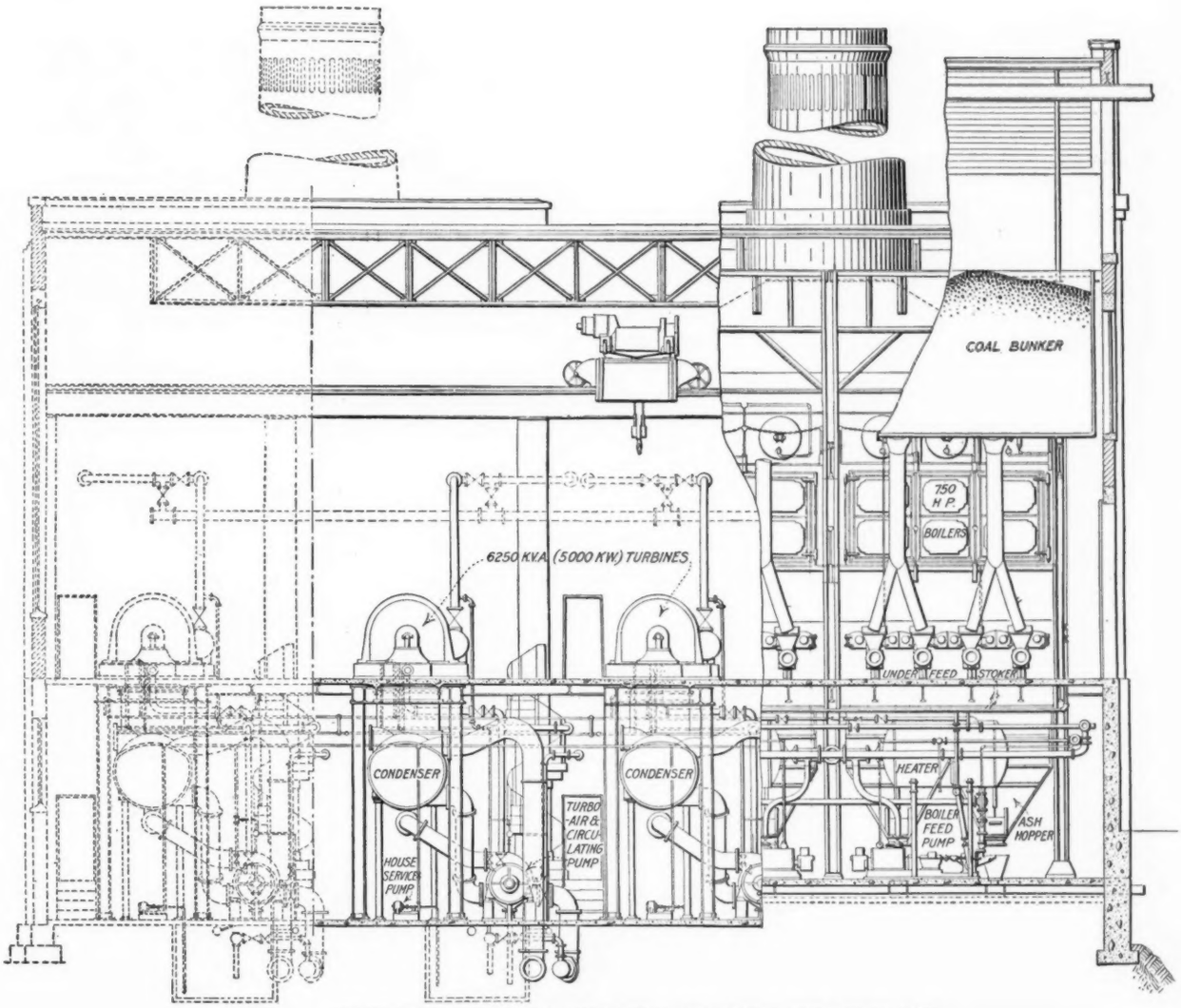


FIG. 6. TRANSVERSE SECTION THROUGH FREMONT POWER PLANT

Furnace draft is produced by four engine-driven fans each having a capacity of 25,000 cu.ft. of air per min. at 2½ oz. pressure. This volume of air is sufficient for the consumption of 7,500 lb. of coal per boiler per hour. Each fan (Fig. 4) is operated independently of the others. The speed of the engine is controlled by a throttling governor, but the steam admitted to the governor is controlled by a regulator that is actuated by the steam pressure carried on the boiler. The steam valves operating the stokers are actuated from the fan shaft, so that a variation in speed of the fan and consequently in the air delivery automatically produces a proportionate variation in the feed of the coal. Between the four draft fans are two turbine-driven boiler-feed pumps, one of which is shown in Fig. 3. The turbines are of the same type and design as those driving the condenser pumps, but are of 100-hp. capacity. The speed of the pumps is brought down to 3,000 r.p.m. by reducing gears. Both

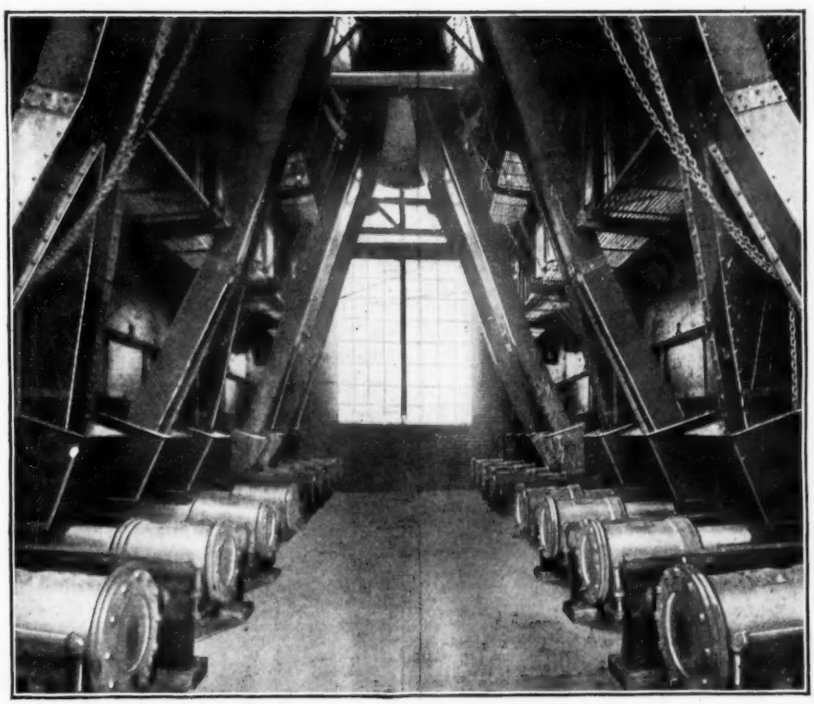


FIG. 7. VIEW OF THE BOILER-ROOM STOKER AISLE

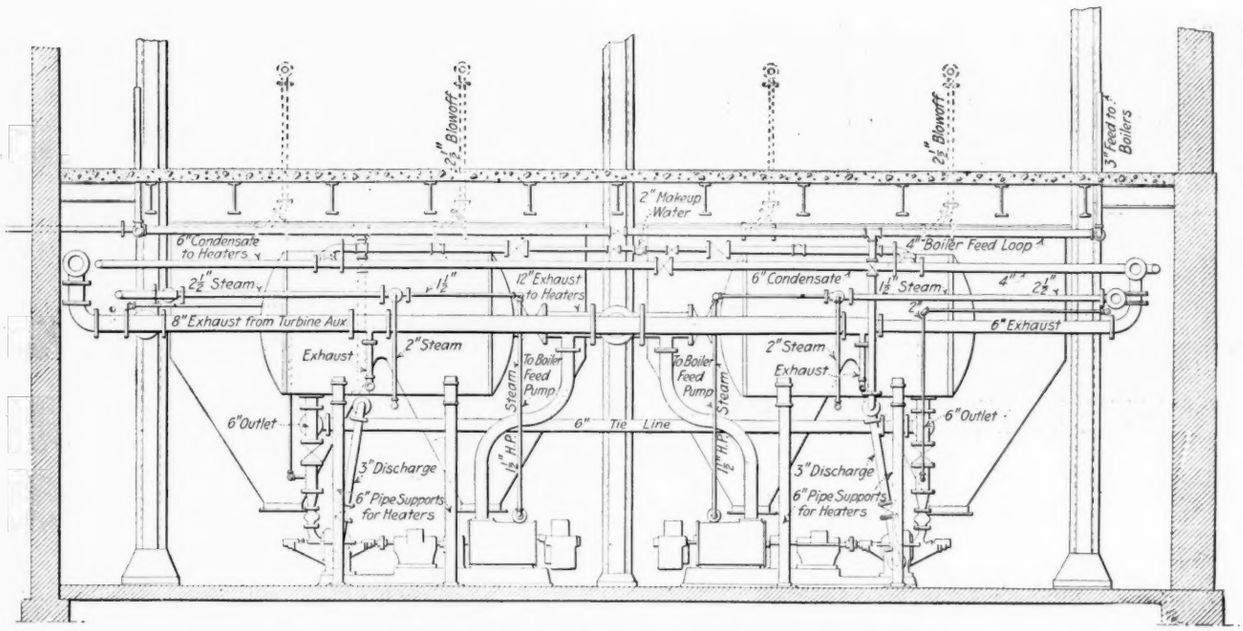


FIG. 8. SHOWING HEATER AND PUMP CONNECTIONS

pumps are four-stage, each with a capacity of 300 gal. per min. at 670 ft. head and 3,000 r.p.m.

Above each boiler-feed unit is an exhaust-steam feed-water heater supported by four 6-in. pipe columns. Each heater is piped from the bottom to its feed pump by a 6-in. suction, both pipes being connected by a 6-in. tie line so that either pump can obtain feed water from either heater (Fig. 8). The discharge from each feed pump connects with a 4-in. boiler-feed loop having a 3-in. feed line branching from the four corner turns.

The main steam-line piping begins with 6-in. branches at the boiler, connecting with an ordinary stop valve and an automatic angle stop and check valve. The branch pipes from each facing boiler connect with an 8-in. line that terminates in a 10-in. header extending across the rear end of the two boilers next to the turbine room. The header and connecting piping are so valved that steam can be supplied to either No. 1 or No. 2 turbine by bypassing the header. No. 3 turbine receives its steam supply from the header. Either set of two facing boilers can supply steam to the header and the other two to either No. 1 or No. 2 turbine through 8-in. pipes. Two 3-in. high-pressure lines supply steam to all auxiliaries pertaining to the boiler-room equipment. These lines tap the 6-in. high-pressure connection between the two boiler outlets, Fig. 5. By this system of piping either of each two facing boilers can supply steam to the apparatus operated in connection with them, independent of the other. This method simplifies the piping work and at the same time provides against a shutdown in case of accident practically the same as if a long loop system were used.

A network of piping for the condenser system has also been eliminated by putting in a simple system by which

PRINCIPAL EQUIPMENT OF NEW FREMONT, OHIO, POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Turbo-generators	Horizontal	6,250-kv.-a.	Main units	250 lb. steam, 3,600 r.p.m., 3-phase, 60-cycle	Allis-Chalmers Co.
3	Condensers	Surface	7,000 sq.ft. cooling surface	With main turbines		Wheeler Condenser & Engineering Co.
3	Turbines	Horizontal reaction	110-hp.	Driving condenser pumps	25 lb. steam, 7,500 r.p.m.	Allis-Chalmers Co.
3	Pumps	Circulating centrifugal	18-in.	Condense circulating water	1,500 r.p.m.	Wheeler Condenser & Engineering Co.
3	Pumps	Air, centrifugal	16-in.	Condense air	1,500 r.p.m.	Wheeler Condenser & Engineering Co.
3	Reduction gears	Falk	150-hp.	Between turbine and condenser pumps	7,500-1,500 r.p.m.	The Falk Co.
2	Motors	Induction	1-hp.	Driving soft-water pumps	1,800 r.p.m., 440 V., 3-phase, 60-cycle	General Electric Co.
2	Pumps	Centrifugal	1-in.	Soft water to transformers and turbine bearings	1,800 r.p.m., motor-driven	American Well Works
3	Motors	Induction	2-hp.	Driving house pumps	1,800 r.p.m., 440 V., 3-phase, 60-cycle	General Electric Co.
3	Pumps	Centrifugal	1½-hp	Raw water to water softeners	1,800 r.p.m., motor-driven	American Well Works
1	Softener	Water	2,000 gal. per day	Softening raw water	By chemical means	Bartlett-Graver Co.
1	Ash vacuum system	Ashes		Handling ashes	Vacuum	Green Engineering Co.
4	Boilers	Babcock & Wilcox	7,629 sq.ft. heating surface	Steam generators	250 lb. steam, 150 deg. superheat	Babcock & Wilcox Co.
4	Stokers	Jones		Boiler furnaces	Automatic	Underfeed Stoker Co. of America.
2	Stacks	Concrete	140 ft. high	Furnace gases	Forced draft	John Voland Construction Co.
4	Fans	Semi-inclosed	25,000 cu.ft. per min.	Furnace forced draft	Engine-driven	Clarage Foundry and Mfg. Co.
4	Engines	Horizontal		Driving forced-draft fans	Variable-speed	Troy Engine Machine Co.
4	Regulators	Mason		Controlling steam to engine governor	Steam-actuated	Mason Regulator Co.
1	Coal system	Monorail	1½-cu.yd. bucket	Handling coal to bunker	Motor-operated	Pawling & Harnischfeger Co.
2	Heaters	Exhaust-steam		Heating feed water	Exhaust steam	Hoppes Manufacturing Co.
2	Turbines	Horizontal reaction	100-hp.	Driving boiler-feed pumps	7,500 r.p.m., 250 lb. steam	Allis-Chalmers Co.
2	Pumps	Multi-stage	300 gal. per min.	Boiler feed	700-ft. head, 3,000 r.p.m.	Allis-Chalmers Co.
2	Reduction gears	Falk	100-hp.	Between turbines and boiler-feed pumps	7,500-3,000 r.p.m.	The Falk Co.
1	Crane	Traveling	25-ton	Turbine room	Motor-driven	Harris-Chfeger Co.

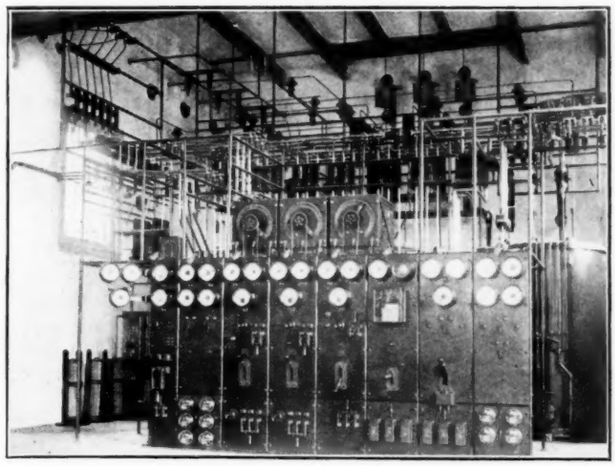


FIG. 9. SWITCHBOARD AND BUSBARS AT THE WATER-POWER PLANT

the turbine driving the condensing apparatus receives steam from the 8-in. steam line that supplies the main turbine, through a 1½-in. steam pipe that is tapped in above the throttle valve, Fig. 5. The 6-in. exhaust pipe from each condenser turbine is carried to an 8-in. exhaust line that connects to the heater. It is also fitted with an atmospheric exhaust. But in case there is more exhaust steam from the auxiliaries (all of which exhaust to a tie pipe between the heaters which in turn is connected to the 8-in. exhaust line) than can be used in the heater, the surplus steam is carried to the low-pressure stage of the main turbine.

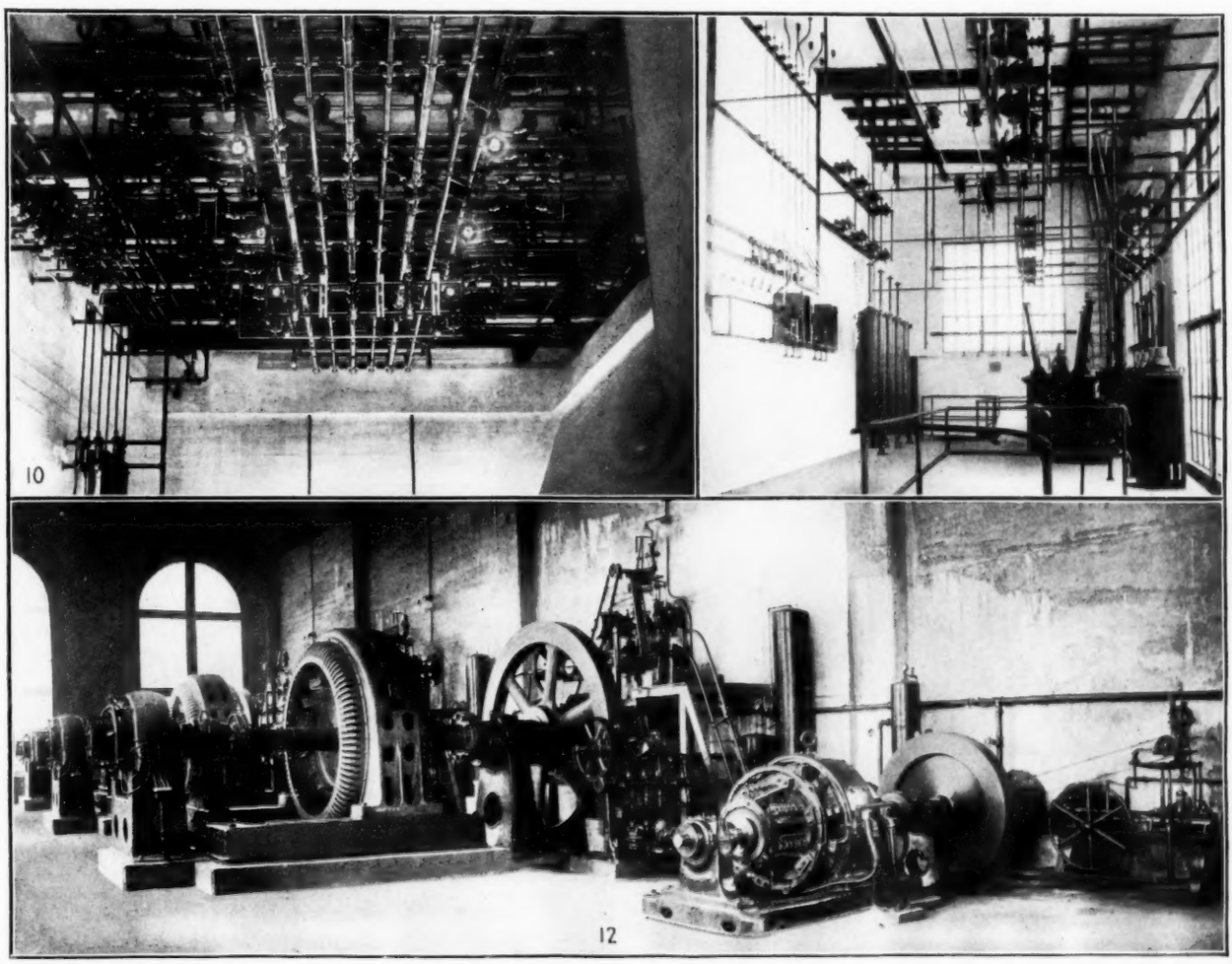
The busbars are located at the end of the turbine-room basement in a concrete room. These and the electrical connections are shown in Fig. 10, the work being suspended from the ceiling. In an adjoining room are the four 1,250-kv.-a. 4,000-66,000-volt step-up transformers.

Oil switches for the high-tension outgoing transmission lines are in a room above the turbine-room floor and at the same end of the building as the bus and transformer rooms (see Figs. 5 and 11).

Operated in connection with the steam units is a water-power plant, Fig. 12. It contains three 4,000-volt three-phase 60-cycle generators running at 257 r.p.m. Each is driven by a 1,900-hp. water turbine operating with a 40-ft. head. A 100-kw. 125-volt exciter is driven by a 200-hp. wheel, also working with a 40-ft. head at 500 r.p.m. A view of the station is shown in Fig. 13. The switchboard and bus construction are shown in Fig. 9.

Water is supplied for the turbine through a penstock that discharges into a concrete forebay, Fig. 13.

The electrical energy generated by these two stations will be mostly taken by the Lake Shore Electric Railway



FIGS. 10 TO 12. WIRING AT THE FREMONT PLANT AND A VIEW OF THE HYDRO-ELECTRIC PLANT

Fig. 10—Overhead busbars. Fig. 11—Oil switches and outgoing high-tension wires. Fig. 12—Water-power plant operated with the steam plant

and the Ohio Light and Power Co. The latter has contracted to use a minimum of 8,000,000 kw.-hr. per year; the Lake Shore Ry. has contracted to use not less than 17,000,000 kw.-hr. yearly.

The transmission circuits for light and power are operated at 60 cycles, 66,000 volts, and the railway transmission is at 60 cycles, 19,100 volts. This voltage is

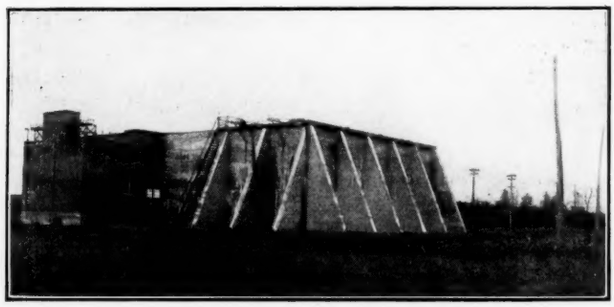


FIG. 13. EXTERIOR VIEW OF THE WATER-POWER PLANT

used to permit of using substation apparatus that was formerly operated at 18,000 volts, 25 cycles.

The steam-power plant was designed and constructed by Woodmansee & Davidson, engineers and contractors, Chicago, Ill. The ratio of maximum kilovolt-ampere-hour output per square foot of floor area is 1 to 0.54, which is low considering the size of the plant.

Quartz Resistance Thermometer

The increasing tendency toward the use of multiple recording thermometers and pyrometers for many industrial purposes has created a demand for measuring instruments for long-distance work. Thermometers of this type working on the electric-resistance system are made by the Hanovia Chemical and Manufacturing Co., Newark, N. J. These are known as Heraeus quartz resistance thermometers. The complete apparatus consists of the thermometer coil, connecting leads, batteries and an indicator mounted on a switchboard panel, on which is also a series of push buttons, which, when pressed one at a time, record the temperatures at the different points where the thermometers are placed, as in Fig. 1. A sliding rheostat for adjusting the battery voltage is placed on the switchboard, to correct the zero point on the indicator.

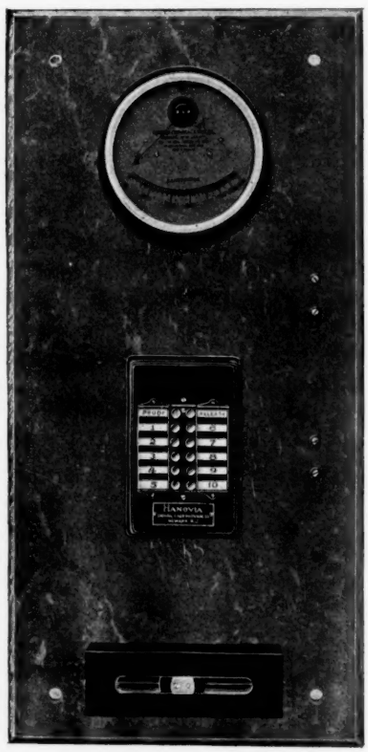


FIG. 1. INDICATOR COMPLETE FOR 10 THERMOMETERS

The thermometers are made on the Wheatstone-bridge principle; a galvanometer G is used for indicating the temperatures, as in Fig. 2. Three known resistances, I, II, III, whose values do not change with the temperature, and a fourth resistance T of chemically pure platinum wire, which forms the actual measuring element, make up the four arms of the bridge. The spirals are wound on fused quartz tubes which are inclosed in outer quartz tubes, hermetically sealed by fusion. The fused quartz remains unaffected by violent temperature fluctuations and protects the platinum against deterioration.

Before taking a reading the operator closes the switch S to the position shown in the figure, thus completing the bridge through a proof resistance P adjusted to bring the galvanometer needle to the end of the scale when the battery voltage is correct. Any necessary adjustments are made by moving the sliding contact of re-

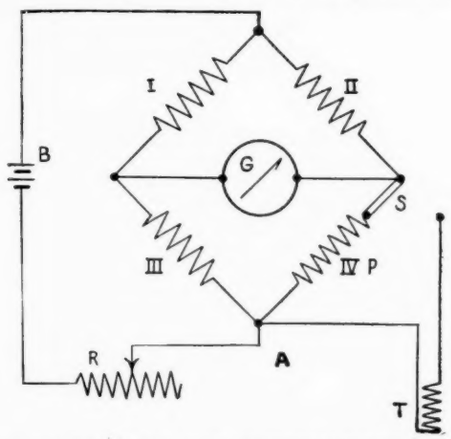


FIG. 2. DIAGRAM OF THE THERMOMETER CIRCUIT

sistance R, after which the temperature readings are taken by throwing switch S to the thermometer resistance T. The system is not confined to one thermometer, but may be used on any number by the use of a scheme of push-button switches, as shown in Fig. 1.

For scientific work a transparent quartz tube is jointed to the resistance unit and no protection tube is necessary, but for industrial purposes a more rugged mounting of double steel rods is used. Protection tubes may be of iron, steel, copper, nickel, lead or silica, depending on the conditions under which the thermometer is to be used.

The indicators are highly sensitive galvanometers moving on a graduated scale. The scale limit may be —200 deg. C. to +700 deg. C. or may have a smaller range. By combining thermo-electric pyrometers on the same switchboard and equipping the indicator with an additional scale, the upper limits may be extended to +1,600 deg. C. Instead of the indicating instruments described, continuous recorders are also furnished.

Size of Steam Pipes for Reciprocating Engines operating at full stroke may be determined by comparing the diameter of the cylinder squared and multiplied by the piston speed per minute with the diameter, assumed, for the steam pipe squared and multiplied by the desired steam velocity. Example: The pipe size for a 20-in. cylinder and the piston operating at 600 ft. per min. is between 6 and 6.5 for a steam velocity of 6,000 ft. per min., since $20 \times 20 = 400 \times 600 = 240{,}000$, while for comparison $6 \times 6 = 36 \times 6{,}000 = 216{,}000$ and $6.5 \times 6.5 = 42.25 \times 6{,}000 = 253{,}500$. The 6-in. pipe would require a steam velocity of $240{,}000 \div 36 = 6{,}666$ ft. per min., while in the 6.5-in. pipe the steam velocity would be only $240{,}000 \div 42.25 = 3{,}857$ ft. per min.

Practical Talks on Controllers--Time-Element Type*

SYNOPSIS—This, the third of the series on direct-current motor controllers, describes the constant-time-element type with butt-end type contacts. The operation of the controller is obtained by the movement of a solenoid plunger dampened by a dashpot. Another form of the time-element type will be discussed later.

The operating engineer or electrician should be familiar with the functioning of electric-motor controller apparatus, because of the increasing use of electric motors for many purposes. He should be able to correct any of the minor troubles that may occur now and then in service. Fig. 1 illustrates a common form of direct-current self-starter, manufactured by the Cutler-Hammer Manufacturing Co. and used in connection with pumping and miscellaneous constant speed machinery. It is known as the constant-time-element type, depending upon the movement of a solenoid plunger, which is dampened by a dashpot, for the proper operation of the rheostat parts. The butt-end type of contact permits commutation of high currents per step, therefore, for equivalent horsepower sizes less steps are required to cut out the resistance. This type is intended to operate where the accelerating period is 15 sec. or less, and on account of its high commutating capacity it is used for loads requiring high starting torque. Note that commutation when applied to a controller refers to the amount of current that the contacts which cut out the resistance can handle without serious sparking.

In the foregoing some of the limitations of this type of controller are pointed out as far as application is concerned, for the reason that ofttimes troubles that are encountered are due entirely to misapplication. Obviously, the butt-end form of rheostat should not be employed to accelerate a high-speed blower or high-speed turbine pump, for the simple reason that such loads cannot be accelerated usually within the commutating capacity of the driving motors in less than 30 to 40 sec.

Four Methods of Control

The form of starter shown is representative of a modern constant-time-element starting device with regard to functions. There are four methods of control employed with a starter of this kind, and the controller circuit is arranged to accommodate connections to any one of them. The most usual methods are by means of pressure regulators, float switches, manually operated snap switches and manually operated push buttons. The first three methods may be classed as two-wire control, while the last is known as three-wire control. The single-pole float switch, diaphragm-type pressure regulator or snap switch constitutes a single-pole switch for closing or opening the control circuit to start and stop the equipment. The complete wiring diagram of electrical connections is shown in Fig. 2, and the method of control is explained in the following discussion.

*The material in this article was contributed by T. D. Montgomery, of the Cutler-Hammer Manufacturing Co.

The control circuit can be traced from *L*1 through the knife switch and fuses to the terminal *L*, and from this point through the single-pole float switch to terminal *C*, and the protecting switch *P* above the solenoid, which is normally closed with the equipment in the off position, through the solenoid and back to the *L*2 terminal, as indicated by the light arrowheads. Closing the float-switch contacts, connected between the terminals *L* and *C* makes a complete circuit to the solenoid, causing it to be energized. The operation of the solenoid causes the plunger to be drawn up within it, thus actuating the rheostat switch *S*. The line wires enter the knife switch at the fuse, and from one side of the switch directly to the short-circuiting member *S* of the rheostat—in

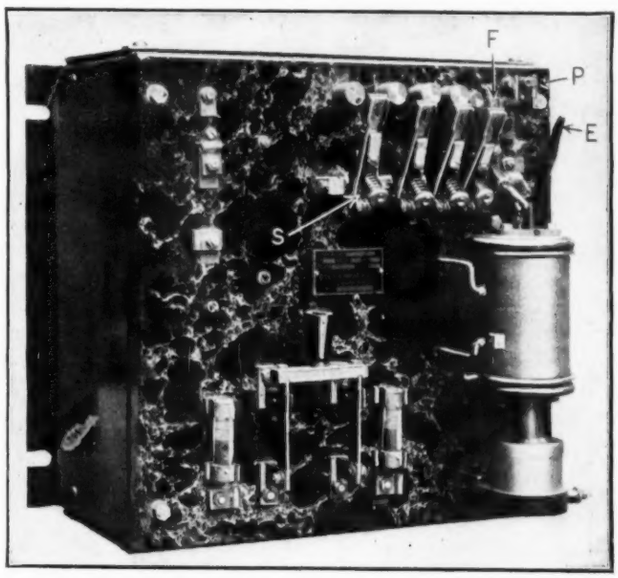


FIG. 1. AUTOMATIC CONTROLLER FOR DIRECT-CURRENT MOTORS WITH BUTT-END TYPE CONTACTORS

other words, to the movable fingers which act to short-circuit the starting resistance. In the open, or off, position there is no electrical connection between the short-circuiting fingers and the terminals of the resistance *R*1, *R*2, *R*3 and *R*4. The movement of the rheostat causes the finger *R*1 to close first, as indicated in Fig. 3, thus completing the line circuit through the resistance to terminal *A*1 on the controller and directly to one side of the armature, through the armature to the *A*2 terminal on the starter, to the switch and the negative side of the line, as indicated by the heavy arrowhead.

The shunt-field circuit is made at *R*1 by the closing of the first finger of the rheostat, the other end of the shunt field being tied permanently to the armature terminal at the motor. The direction of the current is shown by the light arrowhead. The connection between the armature and shunt field is frequently made inside of the motor frame; it is therefore obvious, that in making the connection the wire that connects to the binding post marked *A*2 should always go to the terminal on the motor, which is common to both one end of the shunt field and one armature brush. As the operation of the rheostat

takes place, the fingers are brought in successive contact with $R1$, $R2$, $R3$ and $R4$, each one in turn short-circuiting a step of the resistance, the final finger providing a direct connection from $L1$ to $A1$, thus connecting the motor directly to the line, see Fig. 4.

Just before the plunger reaches its final position an extended arm E connected to the rheostat member shown in Fig. 1 and the wiring diagrams presses against the insulated point I on the protecting switch, making it break contact on its contact post, as indicated in Fig. 4. parallel. The figure shows two stations, X and Y. It will be observed that the starting button is normally open while the stopping button is normally closed as at X. The extra wire is provided for the small finger F at the extreme right of the rheostat switches, which makes contact with its contact post immediately upon the initial operation of the solenoid plunger, as shown in Fig. 3. Tracing the circuit with the starting button closed as at Y, a continuous circuit is made from $L1$ to terminal L through the normally closed push-button

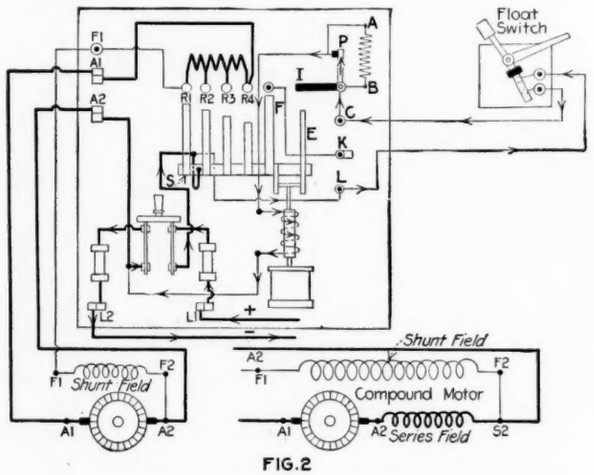


FIG. 2

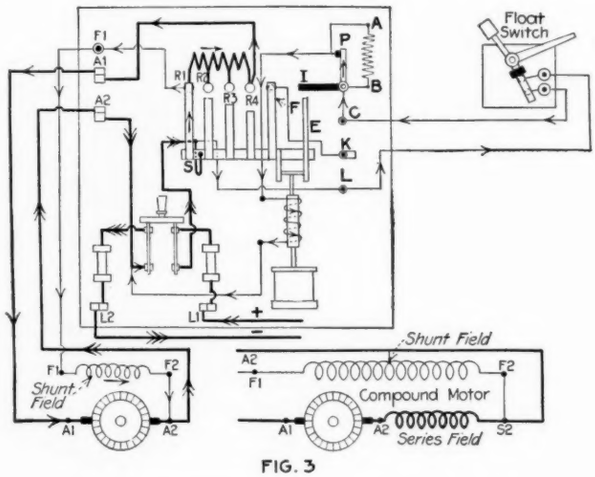


FIG. 3

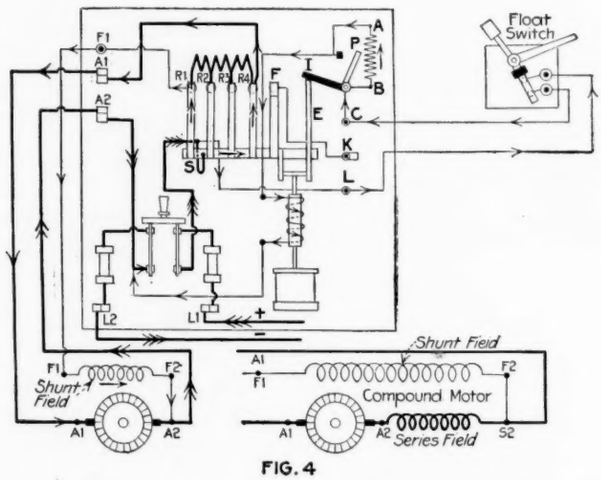


FIG. 4

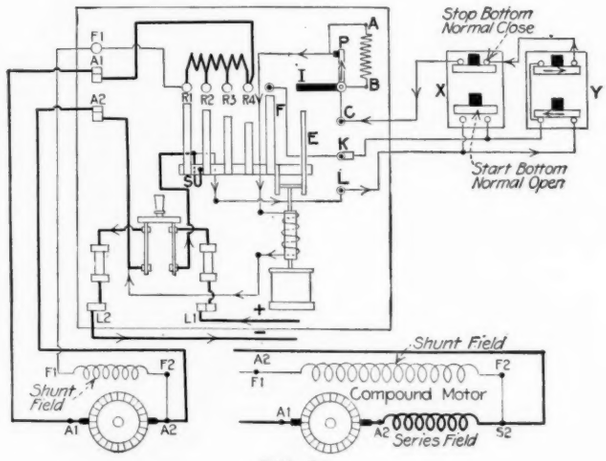


FIG. 5

FIGS. 2 TO 5. WIRING DIAGRAMS FOR CUTLER-HAMMER DIRECT-CURRENT MOTOR CONTROLLER WITH BUTT-END TYPE CONTACTORS

The opening of this switch causes the current to pass, instead of directly from terminal C to one end of the solenoid, through the resistance AB to the solenoid, as shown. This AB resistance is of relatively high value and reduces the current through the solenoid coil materially. Reducing the current through the solenoid coil does not affect the operation as that condition only exists after the plunger has been drawn up in the solenoid and practically sealed, at which time the magnetic attractive force of the solenoid is at its maximum. The reduced current in the coil is sufficient to make it strong enough to hold the solenoid plunger in the sealed position, and at the same time the current is reduced to such a value that the coil can remain continuously in circuit without injurious heating.

With the 3-wire push-button control shown in Fig. 5 any number of push-button stations may be used in circuit to terminal C, from which point the circuit proceeds through the protecting switch to the solenoid-coil winding to the line $L2$, as indicated by the arrowheads. The immediate result of this circuit is to cause the solenoid coil to be energized and the plunger which operates the rheostat to be drawn up. The first movement causes the switch F, already referred to, to close, as shown in Fig. 3, completing the control circuit from $L1$ through the switch member S to K and through the normally closed stop button back to $L1$, or in other words, providing a parallel circuit to that provided by closing the contact of the starting button. The starting button may now be released, and the circuit is maintained to the extra contact F through terminal K. Pressing the stopping button opens its contact, thus opening the maintaining circuit through K, and causes the solenoid to deënergize and the starter to operate to the off posi-

tion. The immediate result of opening the solenoid circuit is to break the circuit, on the auxiliary switch, to the terminal *K*, and therefore the solenoid is not energized again when the stopping button is released, nor can operation again take place until the starting button is pressed.

With this form of control, if the starter attempts to operate when the starting button is pressed, but ceases to function as soon as the starting button is released, it is an indication that the extra switch *F* on the rheostat member is not making proper contact on the initial movement of the rheostat. Insufficient or improper contact in the normally closed button will prevent the equipment being started up at all when the starting button is depressed.

Should the resistance connected between the points *A* and *B* be open-circuited, it is obvious that when the protecting switch *P* opens, the circuit to the solenoid coil will be opened, causing it to be deënergized and release its plunger. The dropping of the plunger will cause the protecting switch to again close, thus completing the circuit to the coil, which would again pull up the plunger and open the protecting switch. This condition is easily identified and is commonly known as telegraphing, as the plunger is merely pulled up and dropped repeatedly.

It should be noted that there is an exhaust vent provided in the dashpot, Fig. 1, which permits the plunger to move without retardation when it has reached a certain point, or in other words, when the rheostat fingers have all made contact. It is just at this point that the protecting switch is operated to open its circuit and insert the protecting resistance. Should the protecting switch become out of adjustment or under any condition break contact before the exhaust point has been reached, the solenoid would be weakened when the retardation was at a maximum, with the result that it would not be strong enough to pull up and seal the plunger. This would make the plunger vibrate in the final position, or it might cause it to remain in an intermediate position with the line switch closed. Care therefore should be taken to see that the protecting switch is always adjusted to open upon the final movement of the solenoid plunger. A break on the protecting switch contact of $\frac{3}{8}$ in. is sufficient.

Should an open circuit exist in any one of the resistance steps connected across *R*1, *R*2, *R*3 or *R*4, current would not be admitted to the motor armature upon the closure of the first contactor. If the open circuit happens to exist between *R*1 and *R*2, the motor would not receive current until the second contactor closes, but as the resistance would be materially reduced, the inrush would be high and there would be a tendency for the motor to start with greater torque than necessary. Should the open circuit exist between *R*2 and *R*3, the motor would not receive current until the closure of the third contact. In this case, the resistance being so materially reduced, the current would be of excessive value, probably causing flashing at the commutator and blowing of the fuses. A similar condition in appearance might exist if the motor was overloaded to such an extent that it could not start on the current admitted to the armature upon the closure of the first or second contact fingers. The difference between the two conditions can be noted, however, by placing an ammeter in circuit and ascertaining whether current flows to the armature as soon as the first switch closes, or if no current flows until the third switch closes. In case of the overload condition current will flow as soon as the first switch makes contact. If the rheostat be blocked so that it cannot operate further than to merely bring the first finger in contact, a test lamp then connected across the terminals represented by *R*1 and *R*2 will burn brightly if the resistance step is open, but will burn dimly if overload condition exists. In the latter case the current should be left on but a moment as the overloaded current would overheat the resistance.

Diversified Service for Diesel Engines

SYNOPSIS—On a single erecting floor there are engines which will drive direct-current generators, alternating-current generators, a ventilating fan, oil pipe-line pump and flour mill through rope drive. The two largest of these engines represent 1,000 b.hp. each.

An idea of the diversified services for which Diesel engines are now being built in this country may be gained from the accompanying photograph showing the erecting floor of the McIntosh & Seymour Corporation, Auburn, N. Y., as noted by a member of the *Power* staff on a recent visit to these works.

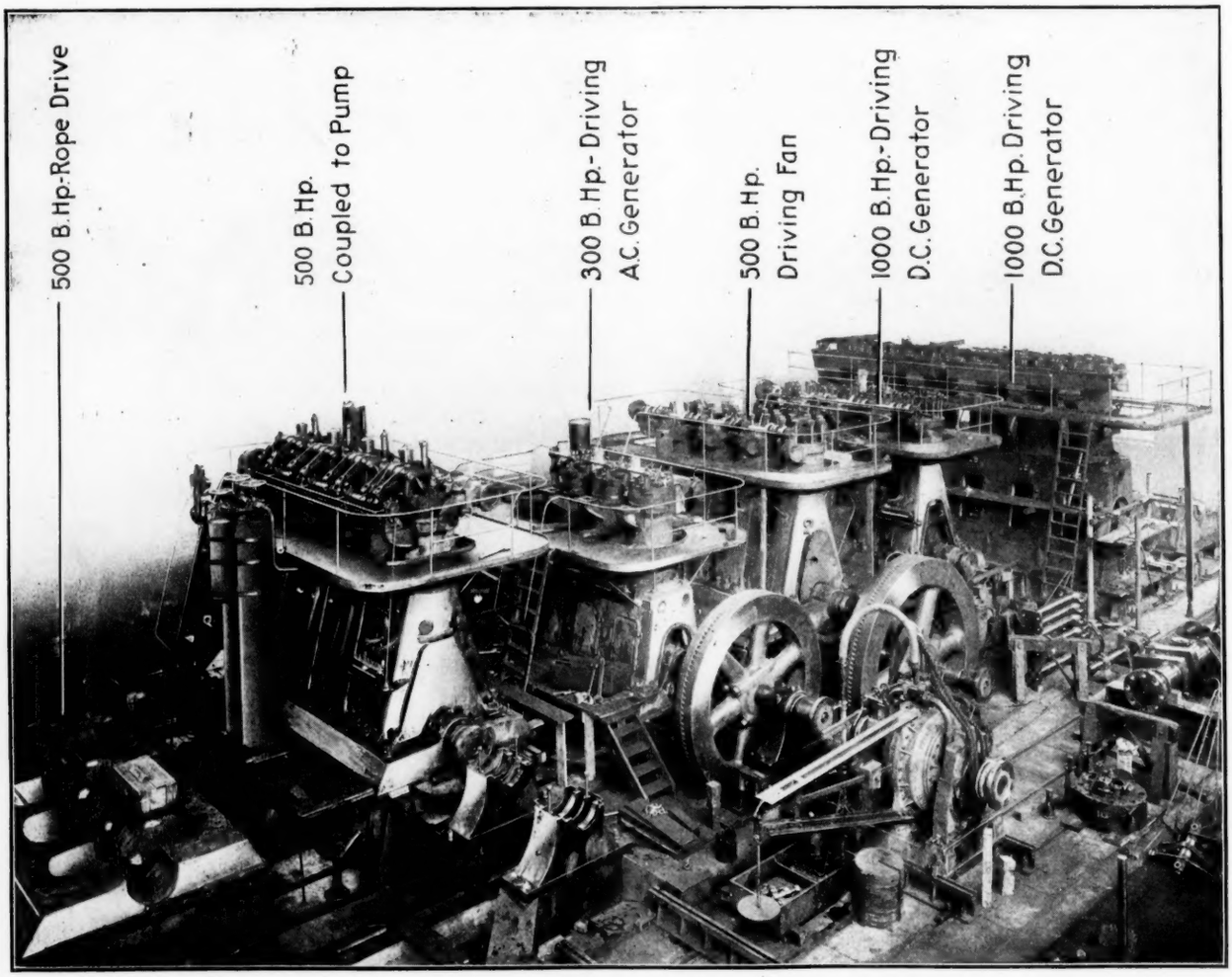
The first engine, which has the base just ready for the fitting of the main bearing shells, is a 500-b.hp. unit for the Midland Milling Co., of North Kansas City, Mo. It will be fitted with a grooved pulley for driving a flour mill by means of ropes and will also drive a generator to furnish power for the motors in the grain elevator and other parts of the mill, as well as electricity for lighting. For this class of work the Diesel engine is well adapted, as a flour mill that is operated 24 hr. a day for about 300 days or more during the year has a high load factor, giving the full benefit of the low operating cost of the Diesel engine. Contributing to this low operating cost are the high thermal efficiency and consequently low fuel consumption, and the low labor cost because fewer men are required. Moreover, the high load factor will make the fixed charges proportionately less.

The next engine is of 500 b.hp. for the Prairie Pipe Line Co., at Ponemah, Ill. It will be fitted with a flexible coupling and will drive by means of gears a high-pressure oil pump for pipe-line service. This engine in general is like the one for the Midland Milling Co., and its desirability for the purposes intended is determined by the same reasons.

The third engine is of 300 b.hp. for the Gowanda Light and Power Co., Gowanda, N. Y. It will operate

a 60-cycle alternating-current generator for central-station service. Diesel engines are becoming very popular for this class of work; namely, small central stations.

The next engine is of 500-b.hp. for the Canadian Pacific Railway Co., and by means of a flexible coupling it will operate large fans for ventilating the new Rogers Pass Tunnel, which is the longest tunnel in North America. The conditions of service in this case are especially favorable to the Diesel engine, as the operation will be intermittent and the engine can be brought up to full load at any time in the course of a minute or two, and when it is shut down there are no stand-by losses of fuel or labor. Also, the Diesel engine, being


500 B.Hp.-Rope Drive
500 B.Hp. Coupled to Pump
300 B.Hp.- Driving A.C. Generator
500 B.Hp. Driving Fan
1000 B.Hp.-Driving D.C. Generator
1000 B.Hp. Driving D.C. Generator

DIESEL ENGINES ON ERECTING FLOOR PRIOR TO SHIPMENT

a whole power plant in itself and taking up less room than a corresponding steam plant, fits in better to the space available at the portal of the tunnel.

The next engine is of 500 b.hp. for the Prairie Pipe Line Co., at Gordon, Kan., and by means of a flexible coupling will drive a geared high-pressure oil pump.

The two engines at the extreme right are each of 1,000 b.hp., the largest four-stroke-cycle stationary Diesels built to date in this country, and are for the Iola Portland Cement Co., Iola, Kan. They will be coupled to direct-current generators and will furnish the power required about the cement plant. As this is 24-hr. service seven days a week, the low operating cost was an important factor in the selection of this type of prime mover.

Uniflow Engine for Automobile

A steam motor car using an engine of the uniflow type, the design of Abner Doble, has been put out by the General Engineering Co., of Detroit, Mich. Several features incorporated in the power plant "listen" strangely as departures from ordinary practice. Among these is the introduction of the cylinder lubrication by way of the boiler, which is of the water-tube type. It is claimed that the oil on the inside surface of the tubes does not cause them to become overheated, partly because they are not exposed to an extremely hot fire. Kerosene oil is carbureted and fed into the furnace by a small fan blower. The engine valves are described as two-piece flat slide valves so made that they will lift from their seats when the compression exceeds the pressure in the valve chest, and are operated by a Joy valve gear.

The engine exhausts into a radiator at the front of the machine, in which the greater part of the steam is condensed and returned to the supply tank, oil and all, to be again pumped into the boiler.

The performance of this unique power plant in service will be of interest to engineers generally.

The Quantity of a Fluid Discharged Through a Pipe or an orifice is increased by heating the fluid to a certain extent, because heat diminishes the cohesion of the particles that exist to a certain degree in all liquids.

Visits of Inspector Brown--XVIII

By J. E. Terman

SYNOPSIS—The Chief continues his comparison of safety-valve rules, tells Brown a few facts that he did not know and shows a diagram that indicates the requirements of the various safety-valve rules under discussion. Brown is of the opinion that if he could show it to Casey the boiler maker, Casey would be better fitted to buy safety valves and incidentally save money.

"Chief," said Brown, as he came into the former's office, "can we proceed with the comparisons of safety-valve rules this afternoon? I am up against the problem of advising one of our assured in regard to the proper size of valves to be placed on some boilers that are being built at Casey's shop, and I know there will be a fight on with Casey unless I have some good 'dope'."

"Why, sure," answered the Chief; "we can proceed with the comparisons, for since we were last discussing this problem I have made some figures and a diagram, which I believe will be an aid in understanding the situation. Looking over the safety-valve rules that are in common use in this country and Canada, it is seen that there are three for this country and one for Canada, besides the rule of the A.S.M.E. Boiler Code. The three for this country are the United States Government rule, the Philadelphia rule and the Massachusetts rule. The Massachusetts rule is the same as the Ohio and the Detroit rules. The Canadian rules for power boilers in the provinces of Alberta and Ontario are the same. These rules are all based on grate area, and by making a few assumptions, we will be able to make a fair comparison of them.

"The Massachusetts rule is

$$A = \frac{770W}{P}$$

where

A = The valve area in square inches required for each square foot of grate surface;
W = The weight of water in pounds evaporated per square foot of grate surface per second;
P = The absolute pressure in pounds.

"The Philadelphia rule, which by the way antedates the Massachusetts rule by twenty years or more, is

$$A = \frac{22.5G}{P + 8.62}$$

where

A = The total valve area required, in square inches;
G = The grate area used, in square feet;
P = The gage pressure.

"The United States Government Steamboat Inspection Service rule is

$$a = \frac{0.2074W}{P}$$

where

a = The area of safety valve in square inches per square foot of grate surface, the same as A in the Massachusetts rule;
W = The weight of water in pounds evaporated per square foot of grate surface per hour;
P = The absolute pressure in pounds per square inch, the same as in the Massachusetts rule.

"You will remember that in the Massachusetts rule," continued the Chief, "the time element was one second; therefore W in the Government rule is 3,600 times the value of W in the Massachusetts rule, since there are 3,600 seconds in an hour.

"The Canadian rule is

$$A = \frac{37.5G}{B + 15}$$

where

A = The total valve area required in square inches;
G = The area of the grate in square feet;
B = The gage pressure in pounds per square inch.

"You will notice Brown," continued the Chief, "that A, G and P in the Philadelphia rule correspond in value to A, G, and B of the Canadian rule. In order that a comparison may be more readily made, we will write down these formulas, one over the other, thus:

Massachusetts	$A = \frac{770W}{P}$
Philadelphia	$A = \frac{22.5G}{P + 8.62}$
United States Government	$a = \frac{0.2074W}{P}$
Canadian	$A = \frac{37.5G}{B + 15}$

"Now, as we have stated, A or a does *not* represent the same value in all these rules, but it is possible to make changes in the formulas and use A to represent the same value in each case, and for this purpose we will say that A is to represent the valve area required for each square foot of grate surface. The Massachusetts formula would therefore require no change, since A in that formula does represent the valve area required for each square foot of grate surface. The Philadelphia formula would merely have the G removed, for that would be the same as making G equal one square foot of grate, and therefore the value for A as given by the formula, thus changed, would be as we have chosen it. The Government rule would remain the same, except that we will change the a to A; for a in the Government rule represents the same value as we are using for A in our changed formulas. The Canadian formula would require the removal of G, which is the same change made in the Philadelphia formula and for the same reason. You will also notice that where P and B are used, they do not represent the same kind of pressure in each case; that is, in some cases they represent absolute pressures, while in others they represent gage pressures, and in rewriting the formulas for comparison, we will make P always represent the gage pressure. Therefore, where P has been taken to represent the absolute pressure, the new value will be $P + 15$, because we will assume that the atmosphere exerts a pressure of 15 lb. per sq.in. Making the W in the Government formula equal to the

W in the Massachusetts formula—that is, multiplying the coefficient of W by 3,600—we have for the Government formula.

$$A = \frac{747W}{P + 15}$$

"Rewriting the safety-valve formulas in the same order as before and with the changes indicated," continued the Chief, "the result would be thus:

Massachusetts	$A = \frac{770W}{P + 15}$
Philadelphia	$A = \frac{22.5}{P + 8.62}$
United States Government	$A = \frac{747W}{P + 15}$
Canadian	$A = \frac{37.5}{P + 15}$

"These formulas are just the same as the original ones, except that the letters used represent the same values in each case, which was not so in the original formulas. In order to get rid of the value W, which appears in the Massachusetts formula and in the Government rule, it will be necessary to make an assumption as to the weight of fuel burned per square foot of grate and the amount of water evaporated per pound of fuel. Although there is not a factor W given in the Philadelphia rule, such a factor is in reality used, for the rule as we have written it serves for boilers operating on natural draft only, and where forced draft is used, the value of G in the original formula is the total number of pounds of fuel burned divided by 16; that is, a safety valve proportioned by the Philadelphia rule is considered correct only for rates of combustion lower than 16 lb. of fuel per square foot of grate surface. For the purpose of comparison," continued the Chief, "we will assume that on an average, each pound of fuel evaporates 9 lb. of water, and that will be stating it high. With 150 lb. working pressure, feed water at 100 deg. F. and fuel of 14,500 B.t.u. per lb., 9 lb. of water per pound of fuel would require a boiler efficiency of about 70 per cent., and they are not accustomed to run much higher than that in regular operation, no matter what kind of a claim you may see made by the boiler manufacturer. Taking 9 lb. of water per pound of fuel and 16 lb. of fuel burned per square foot of grate, so as to correspond with the limits for boilers using natural draft, as provided by the Philadelphia rule, the formulas we have been dealing with would reduce to this form"; and the Chief jotted down the following:

Massachusetts	$A = \frac{30.82}{P + 15}$
Philadelphia	$A = \frac{22.5}{P + 8.62}$
United States Government	$A = \frac{29.87}{P + 15}$
Canadian	$A = \frac{37.5}{P + 15}$

"You can see," continued the Chief, "that on this basis, the Massachusetts formula and the Government rule require about the same valve area. In fact, they would require about the same area on any basis of fuel consumption and pressure, if it were not for the fact that the Massachusetts rule abandons its formula and replaces it with a table that is based on the formula and an arbitrarily assumed variation in the rate of fuel combustion with variations in steam pressure. You will notice that the Canadian rule makes no distinction as to the amount of fuel burned, but requires a fixed size of valve for a given pressure and grate area, regardless of the possibilities of driving the boiler.

"Now, Brown, while you may learn a lot by studying and comparing the formulas as I have just written them down," said the Chief, "the real way to grasp the situation is by plotting the different formulas for safety-valve areas, and then you can see at a glance just how they compare. I have made such a diagram since we were last discussing this matter, and here it is," said the Chief, producing the accompanying chart. "The three lower lines represent the requirements of the Massachusetts formula, United States Government rule and the Philadelphia rule, all on the basis of 9 lb. of water evaporated per pound of fuel and 16 lb. of fuel burned per square foot of grate per hour. The line representing the values given by the United States Government formula is dotted for a purpose, as I will explain to you presently. The heavy line represents the requirements of the Canadian rule for all conditions, regardless of how the possible rate of driving may vary.

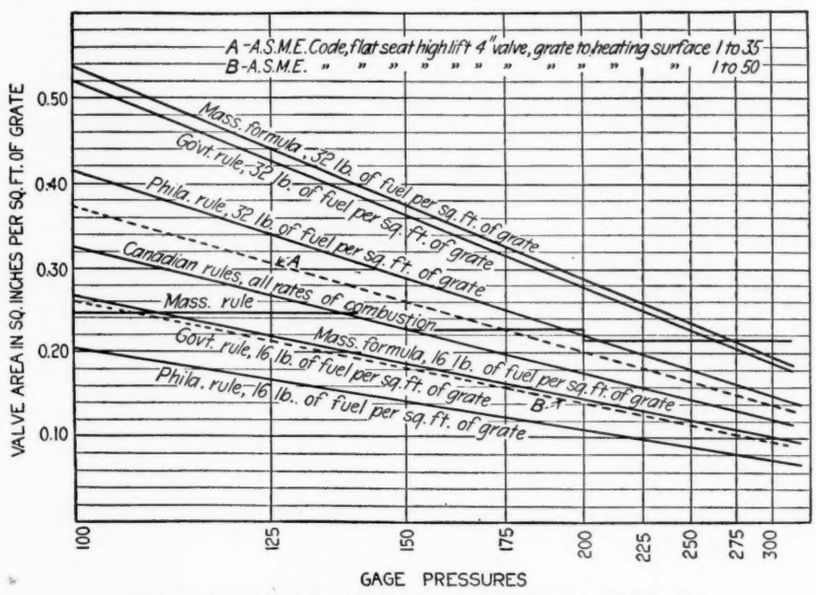

A-A.S.M.E. Code, flat seat high lift 4" valve, grate to heating surface 1 to 35
B-A.S.M.E. " " " " " " " " " " " " 1 to 50
Mass. formula, 32 lb. of fuel per sq. ft. of grate
Govt. rule, 32 lb. of fuel per sq. ft. of grate
Phila. rule, 32 lb. of fuel per sq. ft. of grate
Canadian rules, all rates of combustion
A
Mass. rule
Govt. rule, 16 lb. of fuel per sq. ft. of grate
Mass. formula, 16 lb. of fuel per sq. ft. of grate
Phila. rule, 16 lb. of fuel per sq. ft. of grate
B
VALVE AREA IN SQ. INCHES PER SQ. FT. OF GRATE
0.50
0.40
0.30
0.20
0.10
100
125
150
175
200
225
250
275
300
GAGE PRESSURES

CHART OF SAFETY-VALVE FORMULA REQUIREMENTS

"The three top lines represent the requirements of the Massachusetts formula, the United States Government and Philadelphia rules, where 32 lb. of fuel are assumed to be burned per square foot of grate per hour, 9 lb. of water being assumed to be evaporated per pound of fuel as before. The heavy offset line running across the sheet represents the values as given by the Massachusetts tables for safety valves, which in reality is the Massachusetts rule for safety valves, since the formula on which these tabular values are based is never used for determining the size of safety valves for use on

boilers in Massachusetts. The two dotted lines, the lower of which represents the values by the United States Government rules, as mentioned, and the upper represents the minimum valve area required per square foot of grate surface by the A.S.M.E. Boiler Code rule, on the assumption that a 4-in. valve with the maximum lift and with a flat seat is used, and that the ratio of grate to heating surface is 1 to 50 in the case of the top dotted line, and 1 to 35 in the case of the bottom dotted line, which coincides with the line representing the Government formula with an assumed rate of combustion of 16 lb. of fuel burned per square foot of grate per hour.

"It is impossible, Brown, to show a real comparison between the Code rule and the other rules, for the Code takes into consideration the actual discharge area of a valve—that is, how high it lifts—but all the other rules are based on the nominal area of the valve regardless of its lift. The Government rule and the Philadelphia rule take into consideration the actual amount of fuel burned on the grate, but the Massachusetts rule, as given in the table for determining the size of safety valves, arbitrarily fixes the amount of fuel with certain variations in pressure."

"Gee, Chief! I would like to have that diagram," said Brown. "It looks like a mighty easy way to tell the size of safety valve required by the different rules."

"Well, it would be for the Canadian rule and the Philadelphia rule for natural-draft boilers, and for the Massachusetts rule, by using the heavy offset line across the sheet, but the United States Government requirements are only represented for the two rates of evaporation of 144 and 288 lb. of water per square foot of grate. This diagram would of course be of no value for the determination of sizes of valves under the A.S.M.E. Code rules; I made it for you, however, and I am glad to know that you are interested enough to want to keep it."

"I would like to know, Chief," said Brown, "if you can't tell me how you made that diagram."

"Well, that is too much of a story, Brown, for this afternoon, but possibly some other time we may take that question up."

"Well, Chief," said Brown, "I believe that with this diagram and the other information you have given me, I will be able to intelligently advise our assured as to what rule to follow in equipping his boilers with safety valves, and I believe I can also demonstrate to Casey that if he uses some of that Irish wit and energy that he is wasting on his men and applies it to the problem of how to buy safety valves to meet A.S.M.E. Code requirements, he will probably save some money."

Almost a Complete Change in Pipe Material has been made. Fifty years ago practically all the screw-joint pipe was made of wrought iron, but the invention of the bessemer and the openhearth processes of making steel caused a decided change. Statistical Bulletin No. 3 (1916), issued by the American Iron and Steel Institute, gives the following table showing the production, in gross tons, of iron and steel skelp in the United States from 1905 to 1915, inclusive:

Year	Iron	Steel	Total	Per Cent. Iron	Per Cent. Steel
1905	452,797	938,198	1,435,995	31.5	68.5
1906	391,517	1,137,068	1,528,585	25.7	74.3
1907	444,536	1,358,091	1,802,627	24.6	75.4
1908	297,049	853,534	1,150,583	25.8	74.2
1909	370,151	1,663,230	2,033,381	18.2	81.8
1910	350,578	1,477,616	1,828,194	19.2	80.8
1911	322,397	1,658,276	1,980,673	16.3	83.7
1912	327,012	2,119,804	2,446,816	13.3	86.7
1913	312,746	2,189,218	2,501,964	12.5	87.5
1914	264,340	1,718,091	1,982,431	13.3	86.7
1915	262,198	2,037,266	2,299,464	11.4	88.6

Instructing Firemen To Reduce Smoke from Furnaces

By Martin A. Rooney*

A large part of the work of a smoke inspector consists in instructing firemen in the proper way to handle furnaces for best results. Of course the most effective way of giving this instruction is by word of mouth and by actual demonstration with the shovel and firing tools. But to

*Chief smoke inspector, City of Nashville, Tenn.

DON'T MAKE SMOKE

It is a Violation of the Law.

The smoke inspector is watching your stack.
This furnace can be operated without making dense smoke.
Follow instructions furnished by maker.
Smoke means poor combustion and loss of fuel.

Watch Your Stack. Don't Make Smoke

If you have trouble in keeping down smoke, Call Martin A. Rooney, Smoke Inspector, City Hall. Telephone Main 5100.

FIG. 1. USED IN PLANTS HAVING MECHANICAL STOKERS

DON'T MAKE SMOKE

Directions For Firing Furnaces With Jets and Air Panels

TO START FIRE

Spread a layer of nut coal about 3 inches thick over grates. Put kindling on top of coal and light. When coal is burning brightly start to build up fire.

WHEN FIRE IS STARTED

Keep steam pressure above 80 pounds. Open Jets and panels BEFORE opening door. Fire ONE SIDE AT A TIME. That is, spread coal evenly over one half of furnace and then wait 4 minutes before firing on the other half. Keep Jets and panels open 5 minutes after firing last half. Keep fire level and bright. Keep holes out of fire by firing on bright spots.

CLEANING

Clean one side at a time. Use Jets and panels while cleaning.
Keep ash pit clean. Keep flues clean. Keep boiler, furnace and boiler room clean.

Watch Your Stack. Don't Make Smoke

If you have trouble in keeping down smoke, Call Martin A. Rooney, Smoke Inspector, City Hall. Telephone Main 5100.

FIG. 2. DIRECTIONS FOR FIRING ALL FURNACES USING STEAM JETS OR OTHER AIR ADMISSION DEVICES

DON'T MAKE SMOKE

DIRECTIONS FOR FIRING DOWN DRAFT FURNACES WITHOUT SMOKE

TO START FIRE:

Place wood on top and bottom grates. Light wood. Put coal on top of wood on top grate. When coal begins to burn, build up fire on upper grate until it is 8 inches thick.

NEVER PUT COAL ON LOWER GRATE

WHEN FIRE IS STARTED

Don't Fire any Coal bigger than your fist. CARRY A THICK FIRE ON TOP GRATE, 8 inches or more. Keep fire level by firing on bright spots. Don't let any holes burn in fire. Don't Poke Top of Fire.

Slice Fire on Top Grate by running slice bar along grate UNDER Fire. Keep fire on bottom grate level and clean. Keep ash pit Clean. Clean flues once a day.

WATCH YOUR STACK.
DON'T MAKE SMOKE.

If you have trouble in keeping down smoke, Call Martin A. Rooney, Smoke Inspector, City Hall. Telephone Main 5100.

FIG. 3. DIRECTIONS FOR FIRING DOWN-DRAFT FURNACES

keep these instructions fresh in the minds of the boiler-room crew and to notify new men that they are expected to comply with the smoke ordinance, the accompanying cards are used. They are tacked up in conspicuous places in the boiler room, and one set is usually given to the

DON'T MAKE SMOKE

Coke Must be Burned in this Furnace

DIRECTIONS FOR FIRING COKE

TO START FIRE

Use plenty of kindling. Put kindling on top of paper. Put a few shovelfuls of coke on top of kindling. Open all drafts and light fire.

WHEN FIRE IS STARTED

Carry a THICK fire. Keep fire burning brightly. Don't let fire burn down. Pull all clinkers out of fire as soon as they are made.

TO BANK

Fill firebox full of coke. Open all drafts to start it burning. Then close all drafts. To start from bank, open all drafts to let fire get started and THEN take out all clinkers, before fire gets too hot.

Keep clinkers out of fire. Keep ash pit clean. Keep all parts of furnace or boiler clean

Watch Your Stack. Don't Make Smoke

If you have trouble in keeping down smoke, Call Martin A. Rooney, Smoke Inspector, City Hall. Telephone Main 5100.

FIG. 4. DIRECTIONS FOR BURNING COKE

manager or "boss." Only simple, short words and plain sentences are used in these instructions, since to many of the men using them the task of reading even these is an unusual and difficult one.

Fig. 1 shows a card used in stoker-equipped plants. This is hung under the instruction card furnished by

COKE AND COAL MIXED

If a mixture is used mix FOUR (4) parts coke with ONE (1) part coal.
Be sure that each shovelful is mixed.
Handle Fire same as with coke.

FIG. 5. DIRECTIONS FOR BURNING COAL AND COKE MIXED

the stoker manufacturer and does little more than call attention to the smoke ordinance and admonish the operator to "watch his stack." Fig. 2 shows a card used with all furnaces equipped with wing walls, baffle arches, steam jets and air-admission devices; in fact in nearly all hand-fired high-pressure installations. For down-draft furnaces the card shown in Fig. 3 is used. The only low-volatile fuel available in Nashville is coke, and this is used in a large number of furnaces, in some mixed with coal. The card shown in Fig. 4 is used for the former and that in Fig. 5 for the latter. All the instruction cards end with an invitation to call on the smoke inspector in case any difficulty is met with in operating the furnaces.

These cards have been found excellent for obtaining the coöperation of the boiler-room crew. When it is remembered that after all it is the sincerity and competency of the man who does the actual firing that counts most in maintaining smokeless combustion, the value of the cards becomes self-evident.

Addition of Lap will generally prevent the steam valve from opening sufficiently for the proper admission of steam, hence when the lap is increased it becomes necessary to increase the travel in order to provide the proper port opening. An increased travel of the valve also opens the port more rapidly, which is an important consideration.

Static Discharge from Belts

By R. Thistlewhite

Belt-driven machines that are insulated from ground may cause trouble from static in the belts, causing a fire hazard and also an injurious effect on the insulation of the windings. If the machine is belt-driven by a

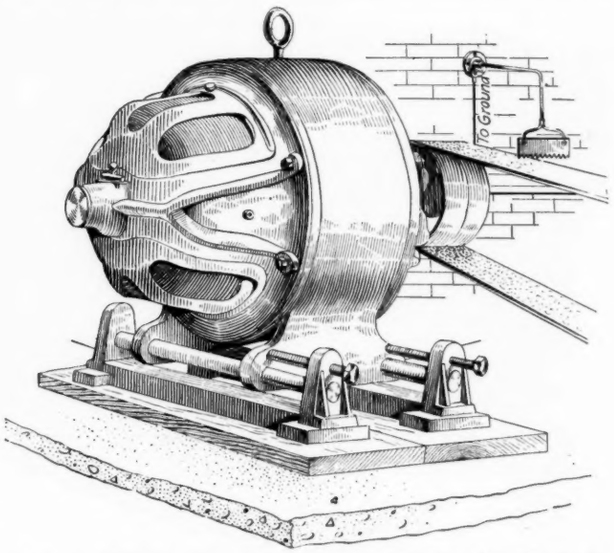


FIG. 1. METHOD OF INSTALLING COMB TO DISCHARGE STATIC FROM BELTS

wooden pulley, a discharge comb made from a piece of $\frac{1}{16}$-in. metal will carry the static charge away without grounding the motor. The comb must not touch the belt, but is supported about 1 in. away from it and grounded as shown in Fig. 1.

If an iron pulley is used, the charge can be taken away by grounding the frame of the motor through a

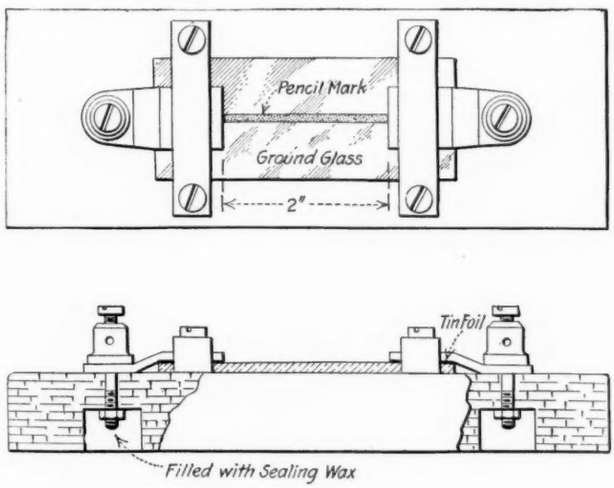


FIG. 2. PENCIL MARK ON GROUND GLASS FOR A RESISTANCE

high resistance. Such a resistance can be made by marking on a piece of ground glass a line of black lead about $\frac{1}{8}$ in. wide and 2 in. long, as indicated in Fig. 2. Tin foil is placed between the metal terminal and the pencil mark to insure good contact and the whole mounted on a slate base. The pencil mark will form a resistance which will discharge any static that may be generated, yet allow no current to pass at ordinary pressure.

Clinkering of Bituminous Coal--III*

By F. C. Hubley†

SYNOPSIS—Discusses the factors that influence results of laboratory fusion tests of ash. Shows the effects of various amounts of dextrin when used as a binder for the ash-test pellets. The author concludes that the use of a binder in Seger cones gives such erratic fusion results as to make their use prohibitive.

The first requirement of a standard laboratory test for ash fusion is the duplication of results on the same ash sample, either in the same laboratory or by two different laboratories, with a fair degree of accuracy. In other words, the results obtained by the fuel buyer's laboratory must be capable of being verified by the seller, if a specification based on the form of test used is to be effective.

The opinion of a number of writers on the subject indicates that the factors governing the results of a fusion test are five in number: (1) General method of making the test; (2) atmosphere surrounding the specimen during fusion, governing the amount of exterior oxidizing or reducing brought to bear on the specimen; (3) effect of binder used in forming the test piece; (4) preparation of the sample; and (5) the rate of heating.

Opinions vary widely as to the relative importance of these factors. Probably the form of test to be used should be considered first. The modified Seger cone method, which in one form or another seems to be generally used, appears to be subject to certain restrictions as noted in previous paragraphs, while some indicating method, of which the fusiometer represents one form, should be an improvement in certain respects.

In regard to the atmosphere surrounding the ash specimen during fusion, the recent work of Fieldner[1] affords ample information in this respect. It therefore remains only to decide on an atmosphere that will duplicate as nearly as possible the combined influences acting on the ash in the boiler fuel bed.

As previously stated, the use of varying amounts of dextrin as a binder for the test piece appears to have considerable effect on the nature of the fusion and the final melting point.

To investigate this factor thoroughly, a number of ash samples representing coals from different localities were mixed with varying amounts of dextrin, and fusion curves developed along with the binder-free ash fusion. In each case the preparation of the sample, the rate of heating and the general method of conducting the test were made as uniform as possible, so that the relative results obtained should be fairly correct.

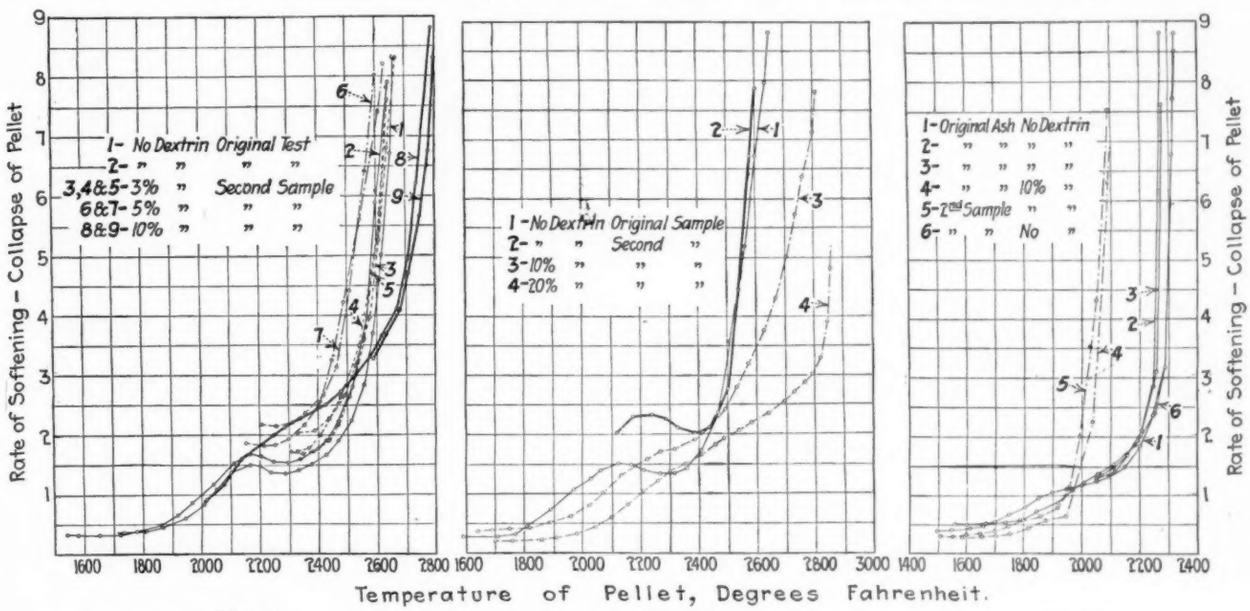

Rate of Softening – Collapse of Pellet
1- No Dextrin Original Test
2- " " " "
3,4&5-3% " Second Sample
6&7-5% " " "
8&9-10% " " "
1-No Dextrin Original Sample
2- " " Second "
3-10% " " "
4-20% " " "
1-Original Ash No Dextrin
2- " " " "
3- " " " "
4- " " 10% "
5-2nd Sample " "
6- " " No "
Temperature of Pellet, Degrees Fahrenheit.

Fig. 12 Fig. 13 Fig. 14

VARIABLE FUSION RESULTS OWING TO DIFFERENCE IN QUANTITIES OF DEXTRIN BINDER IN ASH SAMPLES

Fig. 12—Zero to 10 per cent. dextrin. Fig. 13—Zero to 20 per cent. dextrin. Fig. 14—Chiefly without dextrin

Fig. 12 represents a fairly high fusing ash producing a somewhat porous clinker. Three per cent. of dextrin made no apparent change in the nature of fusion or final melting point, 5 per cent. of dextrin (curves 6 and 7) lowered the melting point 70 deg. F. with no change in viscosity, while 10 per cent. of the binder (curves 8 and 9) increased the melting point 80 deg. F. and changed the nature of the fusion to a close viscous formation throughout the melting range.

Fig. 13 represents fusion of mixtures of 10 per cent. and 20 per cent. dextrin and the natural ash. In this case curve 1 is a test on the original ash sample, while curve 2 was made on a second sample of the original coal sample reduced and prepared independently of the original sample. Ten per cent. of the binder raised the melting point over 100 deg. F. with a viscous formation,

*For Articles I and II see "Power" for Oct. 10 and 17.

†Engineer, American Bridge Co.

[1] "Journal of Industrial and Chemical Engineering," Vol. 7.

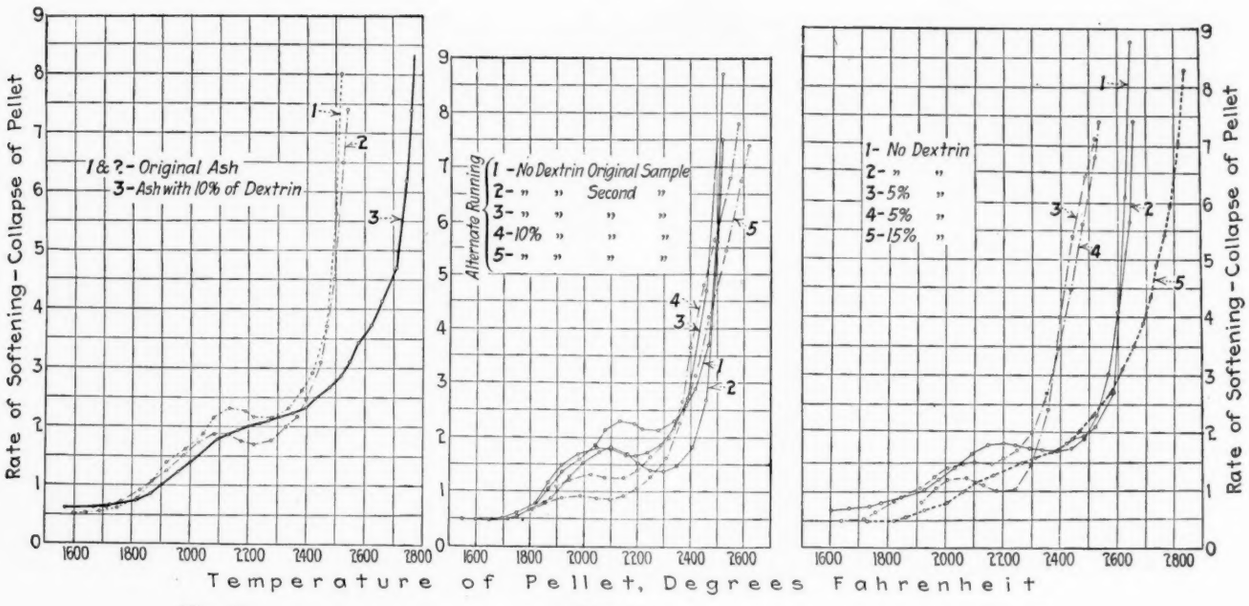

Rate of Softening – Collapse of Pellet
1 & 2 - Original Ash
3 - Ash with 10% of Dextrin
Alternate Running
1 - No Dextrin Original Sample
2 - " " Second "
3 - " " " "
4 - 10% " " "
5 - " " " "
1 - No Dextrin
2 - " "
3 - 5% "
4 - 5% "
5 - 15% "
Temperature of Pellet, Degrees Fahrenheit

Fig. 15 Fig. 16 Fig. 17

FURTHER SHOWING EFFECT OF DEXTRIN ON FUSION TEMPERATURES

Fig. 15—With and without dextrin. Fig. 16—Dextrin had little effect on fusion temperatures. Fig. 17—Notice that 5 per cent. dextrin lowered fusion point 200 deg., while 10 per cent. raised it above that without dextrin

while 20 per cent. raised the melting point 300 deg. F. with increased viscosity.

Fig. 14 represents a low fusing ash of gummy character. Ten per cent. of the binder (curves 4 and 5) lowered the melting point approximately 200 deg. F., shortened the fusing range and lowered the viscosity. Note that in the natural ash fusion, curves 1, 2 and 3 on the original sample are substantially checked by curve 6 on the second sample; also that the 10 per cent. dextrin mixtures from the original and second ash samples agree fairly well.

Fig. 15 again shows a fairly high melting ash with a porous clinker formation, changing, with 10 per cent. of the binder, to a viscous formation with a higher melting point.

Fig. 16 represents an ash upon which the admixture of dextrin had no effect on the final melting point and practically no effect on the nature of the fusion. The second sample of natural ash again checked the original sample in fusing point and formation of the clinker.

The curves in Fig. 17 represent another high fusing ash of the porous clinker formation. Curves 1 and 2 represent the natural ash. Five per cent. of dextrin (curves 3 and 4) lowered the melting point 200 deg. F. and 10 per cent. (curve 5) raised it above that of the natural ash.

In summing up this effect it would appear that if these fusiometer tests are in any way comparable with the Seger cone tests, the result of using binder in these cones is of so variable and marked a nature as to make its use prohibitive in fusion work.

While little has been said of the temperature at which coal should be reduced to ash for fusion tests, probably the lowest possible temperature should be used for incineration. All samples represented by the foregoing curves were burned down in open dishes at 1,200 deg. to 1,250 deg. F. The resulting sample was then ground to pass a 60-mesh screen and thoroughly mixed. Probably 100-mesh samples would afford closer results, although this would depend on the commercial accuracy demanded of the standard test by the fuel specifications.

In the specifications for a standard test some mention should be made of the maximum amount of carbon to be allowed to remain in the sample after incineration, since

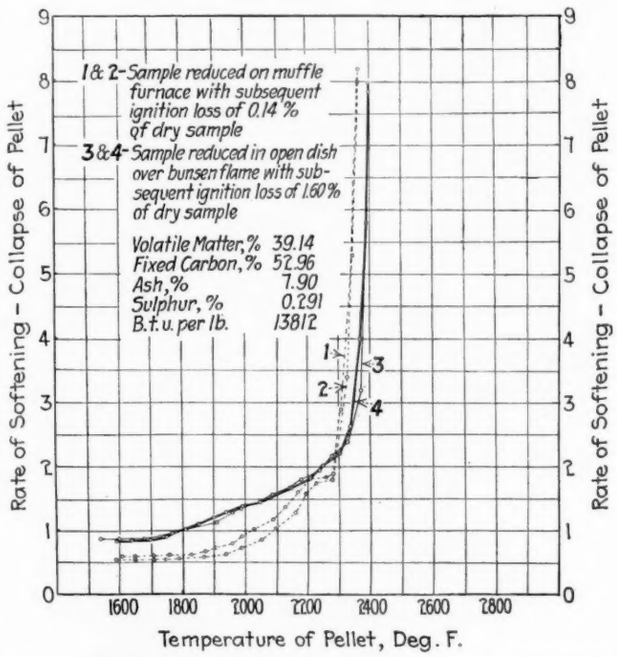

1 & 2 - Sample reduced on muffle furnace with subsequent ignition loss of 0.14 % of dry sample
3 & 4 - Sample reduced in open dish over bunsen flame with subsequent ignition loss of 1.60 % of dry sample
Volatile Matter, % 39.14
Fixed Carbon, % 52.96
Ash, % 7.90
Sulphur, % 0.291
B.t.u. per lb. 13812
Rate of Softening – Collapse of Pellet
Temperature of Pellet, Deg. F.

FIG. 18. SHOWING EFFECT OF COMBUSTIBLE IN SAMPLE

comparatively small amounts appear to change the position of the final melting point and the nature of the fusion. Fig. 18 represents this effect, in which the original coal sample was halved, one half being reduced in a muffle furnace and the other half in an open dish over a bunsen flame. Curves 1 and 2 represent the muffle sample, which had a subsequent ignition loss of only 0.14 per cent. after being ground and mixed. Curves 3

and 4 show the fusion obtained in the dish sample, which had a subsequent ignition loss of 1.6 per cent. The presence of 1.6 per cent. combustible in this latter sample apparently raised the melting point 40 deg. F. with a higher viscosity throughout the softening range.

While it has been shown that quick heating will affect the final melting point, it is probable that for commercial testing faster rates than those usually suggested could be advantageously adopted. Within reasonable limits this rate is an arbitrary matter, to be fixed when the standard test is adopted. The writer suggests 50 deg. F. to 100 deg. F. up to within 200 deg. F. of the final softening, after which 10 deg. F. to 20 deg. F. to the end point.

In Article IV it will be shown that the fusibility of a run-of-mine coal ash will be, in the case of most mines, a variable depending on the mine preparation. It will therefore be desirable for large steam users to make frequent tests on car samples or groups of car samples. The standard test for fusion should be shortened as much as possible as to duration, to compare favorably with the time to make a calorific determination on fuel.

Safety in Use of Oil Burners

By A. C. McHugh

Serious accidents to engineers and firemen are of frequent occurrence from the practice of improper methods of lighting and handling oil fires, and it is the writer's purpose to call attention to a few general rules which, if followed, will greatly lessen the danger of injury to those using oil fuel.

Oil burners may be broadly divided into two classes—those that use steam for atomization of the oil and those that do not. As the former are more generally used, the present remarks will be confined to steam atomizing burners. These are of two types—the inside-mixture type, in which the oil and steam come together inside the burner and are introduced to the furnace through one slot; and the outside mixture type, by which the oil and steam are introduced separately. There is, however, very little difference in the method that should be employed in lighting or handling either type.

In starting a new fire the steam should be turned on and the bypass opened in order that the oil and steam passage may be cleaned out and warmed up. The bypass should then be closed and the steam shut off. Then the damper must be opened. This is one of the most important things to impress upon one's mind. Do not try to start a fire with the damper closed. Next light a torch or bunch of oily waste and place about 10 to 12 inches in front of the burner, turn on a small amount of steam (just enough to carry the oil from the burner tip to the torch) and crack the oil control valve a little. As it generally takes some little time for the oil to fill the burner passage, do not turn on more fuel but wait until the passage is filled, when the fire will light easily.

Until the furnace is thoroughly warmed up, the fire should be closely watched, as it is easily put out, especially if either the steam or oil contains much water. Should the fire go out and the oil still be left to flow, the heat of the furnace will generate volatile gases that will appear at the stack in the form of grayish-white smoke. Should a torch then be applied, a violent explosion would occur. Cases are on record where these gases have been ignited through the breechings of other boilers. The moment the fire is out, the oil should be shut off and the door opened. After a few minutes the gases will have passed off and the fire may be rekindled. When the furnace is hot, there is not so much danger, as the incandescent furnace will immediately relight the oil if its flow should be interrupted for a moment; but even then no chances should be taken, for it is in this way most men are burned. The fire goes out; the attendant opens the door and turns on more oil, expecting it to light immediately, which it generally does, to his sorrow. It is always cheaper to rekindle than to take a chance. In regulating a fire the attendant should hold the door open just enough to enable him to watch the flame and be in a position to duck his head in case of a flare back. To increase the fire the oil valve should be operated first, then the steam turned on until the flame is clear. If not enough steam is used, the flame will appear red and smoky; too much steam will cause the fire to look ragged and will have a tendency to extinguish it. In reducing the flame the steam is throttled down first, then the oil is reduced.

Once the fires have been set, they may be regulated over quite a range by increasing or decreasing the pressure applied to the oil supply without opening the fire-door or changing the steam supply. This can be done by manipulating the pump throttle or a bypass valve between the suction and discharge lines.

When extinguishing a fire, the flame should be cut down as low as possible; then by opening the bypass immediately after shutting the oil valve, the oil passage will be blown out without danger, as the flame will not be extinguished until the passage is clear.

Another point of great importance is that of air supply, or draft regulation. The importance of smokeless combustion is impressed upon the minds of nearly everyone. In fact, a smokeless stack is demanded of all oil-burning plants, but the fact is that a large percentage of these same smokeless plants are operating in utter disregard of fuel economy. One of the chief virtues of oil over coal as a fuel is the fact that on account of its volatile nature, it is more readily mixed with air, thus permitting the air supply to be reduced to a minimum. In properly designed furnaces but little more than the theoretical amount need be used; but in a great many plants little or no attention is paid to this, and as a result, the average oil furnace is more wasteful than the average coal furnace, because of the small resistance offered to the passage of air, there being no fuel bed to check its flow. Thus without close regulation large quantities of air are admitted to be heated and to flow blissfully from our pride, the smokeless stack. The proper method is to reduce the air supply until a faint haze is observed at the stack. This may at first seem difficult, especially with a large string of fires, but after a little practice an intelligent fireman will experience little difficulty even with a widely variable load.

In some plants the stack or breeching dampers are used entirely for air regulation, others use only the draft or ashpit doors, and still others, a combination of the two. From a safety point of view the writer prefers either of the two last-named, although it must be admitted that the pressure drop in the furnace due to the resistance at the entrance will stimulate air leaks through the settings to a greater extent than would be the case should the breeching damper be used. But on the other hand, the draft doors are generally more accessible and more likely to be used and there is not so much likelihood of the dampers being entirely closed and the air supply shut off, for in this lies one of the greatest dangers. Should the breeching damper be closed while the fire is still on, the chances are that an explosion will occur, as the oil in the hot furnace will generate a large volume of volatile gas, which only awaits the admission of air to be ignited with disastrous results. To prevent the possibility of an occurrence of this sort, a safety stop should be placed so as to prevent the complete closing of the damper without removing the stop.

A little common sense applied at the right time will prevent nearly all oil-furnace explosions.

Instantaneous Circuit-Opening Reverse-Phase Relay

In the constantly increasing efforts of power companies to afford all possible protection to life, machinery and manufactured product, the reverse-phase relay has been called upon to play an important part. These companies have been quick to take advantage of the protection thus afforded against the serious results often attendant upon alternating-current power-motor reversals, particularly when these motors are used in connection with elevators, hoists, conveyors, cranes, machine tools and textile machinery. In fact, in some large cities the use of reverse-phase relays in this application has been made compulsory.

Among the common causes of accidental phase reversal are the interchanging of wires by power companies when repairs to cables are made involving a temporary discontinuing of the service mains. This may also happen when additional switching apparatus is installed or when additional service wires are connected.

Protection is required for two conditions: First, where the motor operates normally in one direction only, and second, where the motor, under normal conditions, operates in either a forward or a reverse direction by changing the phase rotation with a controller. In the first case the relay is installed as near the motor as possible, so that when current is thrown on the motor under unintentional reversed phase conditions, the relay operates, opens the motor switch and automatically disconnects the motor from the circuit. In the second case the relay is connected outside of the controlling apparatus for the motor and affords protection for reversals of phase between the controller and the source of power supply.

The new type of reverse-phase relay illustrated is built by the General Electric Co., Schenectady, N. Y., and is made for both circuit-opening and circuit-closing. Both types of contacts are equipped with a toggle *T* so arranged that there is no tendency for the contacts *C* to open or close until the toggle has buckled; the contacts are then, by means of a small spring *S*, quickly thrown to the desired position. The type of contacts required for any installation will depend on the method of tripping out the motor switch. When contactors alone are used, circuit-opening contacts are recommended. The circuit-opening contacts are hand reset. Circuit-closing relays are used in connection with a shunt trip on air or oil circuit-breakers. Contacts of either type are of strong construction and are protected by a dustproof cover.

The relay operates on the same principle as a squirrel-cage induction motor. The operating coils correspond to the stator, and a hollow aluminum cylinder connected to the contacts corresponds to the rotor. The cylinder

RELAY FOR PROTECTION AGAINST PHASE REVERSAL

(plunger) does not rotate, but moves in a straight line, either up or down, depending upon the phase rotation. When one of the phases of the line is reversed, the plunger moves and operates the circuit-opening or circuit-closing contacts.

These relays can be furnished for two-phase or three-phase service with either current of potential windings, depending upon the amount of current and the voltage of the circuit. Current windings, which will cause the relays to operate on phase reversal at 70 per cent. of normal current, are supplied for the following conditions:

For circuits up to and including 100 amperes and 550 volts, connected in series with the line. Potential windings are supplied for circuits up to and including 550 volts, connected directly across the line. These coils are furnished with external resistances of the proper value for the different voltages. Otherwise current and potential transformers are used.

Babbitt Metal should not be used over and over again for the reason that every time it is melted some of the tin and antimony is burned out. The scum that appears on the top of the metal when it is heated is an oxide formed by the combination of the metal with oxygen from the air.

Editorials

Cylinder Lubrication

One of the most indeterminate things about a power plant is the amount of lubricant that is needed for the engine cylinders. In our issue of Feb. 15, 1910, was published the result of an attempt to gather and collate the experience and practice of *Power* readers in this respect. These results varied widely, and naturally so, as what would be satisfactory lubrication to one man would not satisfy another.

If one is content to use as little oil as possible without inducing an audible or visible symptom of its lack, he may end by using no oil at all, for it is entirely possible to run a cylinder with no oil without cutting it or making it groan. Unless there is some special reason, such as the avoidance of oil in the condensate, one would hardly run an engine in this way. The friction must be considerably greater, and there is no reason why lubricant is not as desirable and effective inside a cylinder as out. To make the story of comparative cost of lubrication complete, one must have not only the amounts of oil used and their costs, but the friction and wear of the lubricated surfaces. If there were an easy method of determining these, a standard of lubrication could be fixed; and it would be easy to determine the amount and cost of lubricant necessary to maintain it. An interesting discussion of the subject by Bruno V. Nordberg will be found on page 600.

Single-Phase Power from Polyphase Systems

Contrary to earlier practice in the electric industry, which was to supply each class of service from machines especially designed for a particular purpose, the tendency today is to supply all the power needs of a community from the same generators. In studying the past development of the industry we find that various types of generators were employed—one for interior lighting and direct-current industrial motors, another for street lighting, and the third for street-railway service. In addition to this was the alternating-current system with its numerous frequencies and phases, all requiring different generating machines.

In the large central stations of today this multiplicity of needs is supplied from an alternating-current generator. On account of the economy of generation and transmission, this unit is usually a three-phase high-voltage machine. Of late other needs for power have arisen, most notable among which are the electrification of trunk-line railways and the electric furnace. These two classes of service usually require single-phase alternating current, and this introduced another problem for the central station—to supply large amounts of single-phase power from polyphase machines; that is, if the central station is to take full advantage of the diversity of the total load of the territory which it serves. Therefore, the power company must stand ready to deliver to the customer, irrespective of the demands, power of uniform pressure, either direct- or alternating-current of a voltage, frequency or phase best suited to his needs.

To meet the demands for single-phase power from polyphase systems did not offer any great problem, as it could usually be balanced between the different phases, until the introduction of the single-phase railway and the electric-furnace load; and then new means had to be provided to take care of it.

The solution of this problem by the electrical engineer and central-station owner was the subject to which the Philadelphia meeting of the American Institute of Electrical Engineers was devoted. Four papers were presented on the production of single-phase power from polyphase systems, abstracts of three of which are published elsewhere in this issue. As set forth in these papers, the effect of a heavy single-phase load on one phase of a three-phase system not balanced by other single-phase customers introduces new problems. The capacity of the generating apparatus is reduced to that limited by the heavily loaded phase, and the voltage of the system is thrown out of balance. In the first case some means must be provided to divide the load between the different phases to enable the generators to operate at their normal capacity. In the second case the voltages of all three phases must be maintained balanced and constant if all the consumers are to obtain a satisfactory service.

Several methods are available to accomplish this: A copper structure embedded in the generator core similar to the squirrel-cage winding of an induction motor, or by phase converters, motor-generator sets, synchronous phase balancers, etc. Each of the different schemes has its own distinctive advantages and disadvantages. According to the opinions expressed at the meeting, each case must be worked out by itself and the best means of solving the problem adopted. What has been accomplished so far shows very clearly that the electrical engineer is capable of mastering this new situation, as he has many others in the past.

Oil Viscosity Discussion

In several past issues of *Power* readers have discussed the value of the viscosity test for cylinder oils; this discussion still continues. Naturally, the letters from those participating have been interesting contributions to the literature on this subject because that property called viscosity is so vital to the desired functioning of an oil. To carry the definition of viscosity beyond the viscosimeter, what does it mean? What is it supposed to do? What temperature do you measure it at for comparison with other oils? Should it be measured at one hundred degrees or at the temperature under which it is to be used to determine how that property will act when the oil is applied? How should one treat viscosity in cylinder-oil specifications? The foregoing are some of the questions considered so far in the discussion.

The author of the latest contribution, which appears elsewhere in this issue, emphasizes the desirability of having different users publish their cylinder-oil specifications in *Power*. Quite likely the appearance of such specifications would be of help in this discussion; they would be interesting in themselves anyway, and the pages of this paper are open to those who care to publish such specifications.

Furthermore, the publication of oil specifications at this time would be welcome because of the generally renewed interest in oil and lubrication as shown by the great volume of literature on the subject that has appeared within the last three years.

California's Boiler Rules

The Industrial Accident Commission of California is now distributing copies of its boiler rules, which go into effect January first of next year. The rules for the most part are made up of the Boiler Code of the American Society of Mechanical Engineers, which is printed in full in the California rules book. Experience has shown that this is the best way of adopting the Code in any state—that is, to print the entire Code in the bill introduced.

A few pages in the front of the book give rules that the commission has deemed advisable to add to the Code. Paragraph (d) of order number eight hundred, the first in the book, contains a sentence that is significant; namely, "Enough of the brickwork shall be removed to determine the condition of the boiler, furnace or other parts, at each annual inspection." If we interpret this sentence rightly, it would appear that California, at the beginning, was making provision for the quick discovery of weakened joints that may be buried beneath a layer of brick. The reader recollects that the matter of removable covers at boiler joints was agitated not so long ago before a meeting of the Massachusetts Board of Boiler Rules, inspection having revealed such weakened joints in some of the boilers thus stripped that immediate discontinuance of service was ordered.

No new power boilers shall be installed in California after January first next that were not stamped when built with the imprint of the American Society of Mechanical Engineers' Boiler Code, except after a joint inspection by the commission and a certified inspector. The lowest factor of safety allowed on these boilers is six, although boilers in stock in the state on or before January first may be installed, using a factor of safety as stipulated for existing installations. These factors, particularly those relating to lap-seam boilers, are not the same as appear in the Code. The differences will be given in an article in next week's *Power*. The factors as changed by the commission are commendable in that they are increased as the boilers get older, whether the shells or drums are or are not exposed to the products of combustion. Although new installations require a factor of safety of five, for existing installations the commission has again been more specific than the Code. Paragraph three hundred and seventy-nine of the Code states, "Boilers in service for one year after these Rules become effective (with the idea of giving a year's grace for existing installations to conform to requirements) shall be operated with a factor of safety of four . . ." The commission specifically says "boilers of butt and double strap construction." This was done, it seems, to avoid using a factor of safety of four for lap-seam boilers, the lowest for this construction being four and one-half. Because of the agricultural interests perhaps, the commission, in stating the allowable factor of safety for second-hand boilers says, "second-hand stationary boilers." The Code merely says "second-hand boilers."

The commission has been more liberal than the Code as to the allowable pressures on boilers having cast- or malleable-iron headers or mud drums. The Code limits the pressure on such boilers for existing installations to one hundred and sixty pounds. The commission allows a limit of two hundred pounds provided the cast- or malleable-iron parts are replaced by parts of forged steel or steel castings within five years after the rules go into effect. If this is not done, the pressure must be reduced to one hundred and sixty pounds. This is indeed a fair way of meeting the objections on this matter which were raised during the formulation of the Code. There are those who will contend, however, that the commission has been too liberal in this matter of cast iron.

Evidently to avoid the possibilities of a "tangle" over the interpretation of the paragraph relative to the allowable pressure on steam heating boilers, the commission says the pressure "shall not exceed fifteen pounds per square inch on a boiler *designed* exclusively for low-pressure steam heating." The Code says, ". . . *used* exclusively for low-pressure steam heating." A literal interpretation of the Code does not permit of more than fifteen pounds on a boiler which may have been designed to safely carry, say, two hundred pounds, if that boiler is *used* for low-pressure steam heating.

Because of the use of cast iron for high pressures, the commission orders that "when the strength of cast iron is not known, it shall be taken as eighteen thousand pounds per square inch." The tensile strength for steel plate is taken as fifty-five thousand pounds, and for wrought-iron plates, forty-five thousand pounds.

Every boiler inspector, particularly, will rejoice to learn that the commission requires a one-quarter inch valved connection on every boiler for a test gage.

The commission does not order the use of automatic nonreturn stop valves, but recommends their use. We would be interested to know why they were not ordered.

The authors of those letters that appear from time to time in the power-plant journals on the advantages of feeding through the blowoff will be disappointed to learn that the commission prohibits this manner of feeding, ". . . unless clearly impracticable to introduce the water elsewhere." Another commendable action of the commission is that where a boiler is over fifty horsepower, more than one mechanical appliance (pump, injector or inspirator) is required to be provided.

Operators have long quarreled as to how high above the working pressure the hydrostatic test pressure should be carried. The Code requires that it be one and one-half times the working pressure. The Massachusetts rules (amendment sixteen) states that this pressure shall not be less than one and one-quarter nor more than one and one-half times the maximum allowable working pressure. The Ohio rules do not permit it to exceed one and one-half times the allowable working pressure. The commission has made what will probably be a successful effort to satisfy the most fastidious by allowing this pressure to be anything between the maximum allowable working pressure and one and one-half times that pressure.

Correspondence

What Blistered the Boilers?

The only safe place to deliver feed water in a horizontal tubular boiler, in my opinion, is on top of the tubes directly in the center crosswise and one-fourth the length of the boiler from the back head. At this point the circulation is downward and the incoming water mingles thoroughly with that in the boiler before being brought in contact with a vital part of the latter, and the deposit always found at the delivery end of the feed pipe will be on the tubes, where it will do the least injury and may be easily removed.

The statement by Mr. Blanchard on page 392, issue of Sept. 12, that poor circulation caused the blister may be correct, but I do not see how circulation can be improved by delivering cold feed water at the bottom of the boiler, where it would naturally lie if undisturbed; for the thing that increases the circulation of water is a disturbance of its natural relation. I should suggest the skull and crossbones as a proper insignia for a system of feed pipes as advocated in the letter referred to, as I believe that it would cause girth-seam leaks, fire cracks, bags and about all other dangerous ills that boilers are heir to. T. J. Bloss.

Chattanooga, Tenn.

Fastening Valve-Rod Plates

Many plants have Westinghouse steam-driven air compressors and not infrequently experience trouble through the loosening of the capscrews holding the valve-rod plate. It is the common practice to secure the bolts by means of a thin sheet-metal lock washer, as shown in Fig. 1,

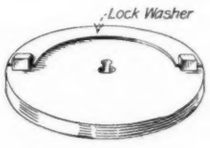


FIG. 1. LOCK WASHER

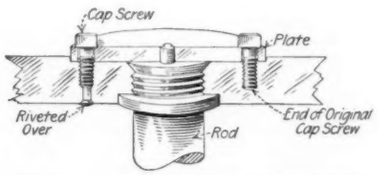


FIG. 2. CAPSCREW EXTENDED AND RIVETED

but they sometimes permit the capscrews to work loose and entirely free themselves from the head, getting between the top head and the steam piston and bending the rod at the neck, where it is almost impossible to straighten it. Fig. 2 shows a quick and practical method of permanently securing the bolts and plate. A $\frac{9}{32}$-in. hole is drilled down through the steam piston from the bottom of the $\frac{3}{8}$-in. capscrew opening (piercing the steam piston) and countersunk on the under side with a drill or small cape chisel. A new $\frac{3}{8}$-in. capscrew with the end turned down to $\frac{1}{4}$ in. is then used to fasten the plate and the end peened or riveted over into the countersink. This fastens the plate and bolts rigidly, and even should the bolts become a trifle loose, the riveted end will not allow them to work out. F. W. Bentley, Jr.

Missouri Valley, Iowa.

Water-Hammer in the Discharge Line

In reference to the arrangement of the piping shown on p. 105 in the issue of July 18, it is to be hoped that no centrifugal pumps were ever so connected—that is, with short ells and so many of them apparently unnecessary.

The reason pump *A* did not feel the effect of the water-hammer so severely was that the impeller and water in its casing were probably still in motion and cushioned the blow. The means adopted was the correct one, although the effect of the water-hammer might have been modified by a large air chamber on the discharge line and also by a relief valve. Robert E. Newcomb.

Holyoke, Mass.

Probable Cause of Ammonia Compressor Trouble

In the Sept. 26 issue of *Power* H. A. Green tells about the trouble he is having with an ammonia compressor and says that during the recent hot weather he had to speed up the machine more than usual. This would indicate two things, assuming that the trouble is in the compressor. Either the valve in the piston is badly worn and leaks gas back into the suction pipe on the compression stroke—and a very small leak will greatly reduce the output of the compressor—or the discharge valve, which he states is the whole head, may have become worn and leaks high-pressure gas back into the cylinder on the suction stroke, which is more probable than that the suction valve leaks. A small leakage through the valve will decrease the output of the compressor and make higher speed necessary to handle the given quantity of ammonia. Another trouble may be that the rings on the piston are worn.

If any of the causes mentioned is the real cause, the temperature of the high-pressure gas will be abnormally high and the suction line will not frost back as quickly as it should. The leakage of gas through the piston rings or valves causes it to become superheated in the same manner as leaking valves in an air compressor, in which case, when the discharge valves are in bad condition, the air may be heated to the temperature at which it will ignite at the pressure of discharge and explode it. This happens not infrequently. An explosion of this nature might not be possible in an ammonia compressor, but the capacity of the machine would be reduced.

As a remedy I would suggest that the cylinder head be taken off and a thorough examination made of the valves and piston rings. If the cylinder is scored badly, it may need reboring, but in a vertical cylinder this may not be the case unless some of the rings are broken and the sharp corners have scored the cylinder. Examine the intake or suction valve in the piston head, and if badly worn, a new one may be necessary; otherwise I would grind it in with carborundum, using a medium grade at the start and finishing with a fine grade. The same treatment should

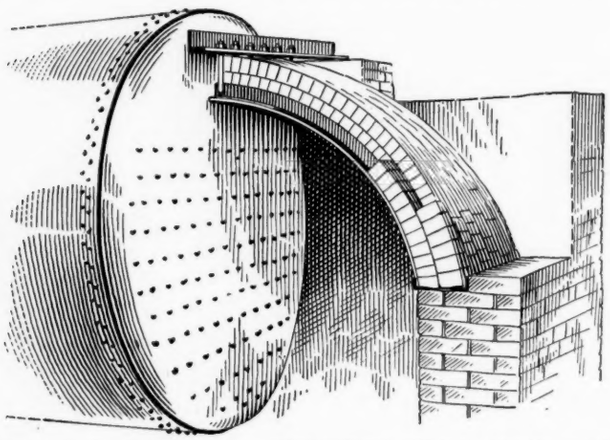
be given the discharge valve, as the area of the seat is so great that a leak which would have considerable effect on the capacity may not be seen. When this seat is ground in, the valve is of course lowered, and unless the crank bearings are worn the piston may hit the head at the top center; lowering the head weakens the spring tension, and a shim should be placed under the spring to give it the proper tension.

The dull season is now at hand, and I would advise giving the compressor a thorough overhauling to see that every part is in good working order.

Hyattsville, Md. J. C. HAWKINS.

Holding Rear Arch Brick

We have found a satisfactory method, shown in the illustration, of holding the firebrick arch at the rear of a horizontal return-tube boiler. The difficulty commonly encountered from the expansion of the boiler pushing the arch back and the contraction in turn letting it settle down so low that it finally gets in the way of the tubes



UPPER END OF ARCH SUSPENDED FROM ANGLE BAR

is overcome by this form of construction: A channel bar is set into the rear wall as a rest for the lower end of the arch, and an angle bar having a number of holes, as shown, extends across to the side walls at about the top of the boiler. The arch bars are suspended from this upper angle bar by hook-bolts with long threads for adjustment. They may be ordinary bolts, heated near the heads, put through the holes in the arch rib and bent up into a hook. We feel that we have solved a problem that engineers are working and worrying over a lot, and we pass it along for the benefit of all.

Grinnell, Iowa. O. THORP.

Overcoming Inductance

The articles by Grover C. Long, page 391, Sept. 12, and E. C. Parham, page 233, Aug. 15, issue of *Power*, on the subject, inductance of reels causing reduced voltage and slow motor speeds, are interesting, but neither tells how to remedy the trouble without splicing every time the location of the dredge is changed.

If the three wires are wound closely together on one instead of three reels, there will be no voltage drop from inductance. By means of three collector rings on the outside of the reel, a far more satisfactory method for frequent moving is obtained than by splicing. It may be necessary to tie the three wires with twine every 20 or 30 ft. so as to keep them close together; also, all three wires must have the same number of turns on the reel. The idea is to have the current circulate through the coils in both a clockwise and counterclockwise direction. This principle is taken advantage of in all alternating-current heating devices, stoves, etc., where inductance would be objectional. EDWIN C. HUTH.

Cincinnati, Ohio.

Viscosity of Cylinder Oils

A significant note has been struck in the discussion of cylinder lubrication by Charles E. Carpenter and others in *Power*. In his discussion of Mr. Carpenter's article, some extremely good things were presented by F. L. Fairbanks in the issue of May 18. I do not believe, however, that he has correctly interpreted Mr. Carpenter's remarks. I wish to join with the latter in protesting against Mr. Poole's claim that the criticism of viscosity as a criterion of lubricating value comes only from those interested in selling cylinder lubricants composed largely of animal fats.

To explain my opinions adequately would require much space, so I invite the reader's attention to two bulletins of the Engineering Experiment Station of the University of Missouri. The first is by A. E. Flowers, who, while a member of the engineering faculty, became interested in the subject of cylinder lubrication, and taking advantage of the encouragement the university offered in the matter of research, designed a unique apparatus for testing cylinder oils under the conditions approximating those obtained in the cylinder of an engine. A description of this apparatus is given in the Engineering Experiment Station Series of the University of Missouri, Vol. 2, No. 2.

The writer had the advantage of working with Mr. Flowers, who gave particular attention to the subject of viscosity. He observed that there was a radical change in viscosity as the temperature of the oil changed, until the viscosities of oils radically different at the temperatures at which tests are ordinarily made became almost identical at high temperatures. He found that this result had been obtained by some other investigators, most notably by Wells and Taggart, of Manchester, England. These gentlemen had collected hundreds of samples of oils from all over the world and had made most exhaustive tests, which they had published in an excellent book that should be read by all interested.

When Mr. Flowers left the university, M. P. Weinbach, also of the engineering faculty, continued the work, publishing his findings in Engineering Experiment Station Series, Vol. 4, No. 2. This is an excellent number of the bulletin.

The general result of the investigations of these men is to discredit the value usually attached to the characteristics of oils in the manner in which they are conventionally handled and stated. Not only does the viscosity change at cylinder temperatures and pressures, but the same thing is observed of other properties. Furthermore, oils ranked or graded on one characteristic will prove to be different on some other characteristic. Most painstaking tests were made on some nine samples of cylinder oils sold by the companies in the Missouri Valley. These were also analyzed in the local United States laboratory. I have labeled these oils A to I and reproduce in the follow-

ing table in the order of their respective standing in the various tests, beginning with the lowest value in each case:

Friction Coefficient at 50-lb. Gage, 0.6 C.C. per Min.	Per Cent. of Animal and Vegetable Fats	Viscosity at 212 Deg. F.	Viscosity at 327.8 Deg. F.	Specific Gravity at 100 Deg. F.	Flash Test, Open, Deg. F.	Fire Test, Open, Deg. F.
I	B	G	G	F	H	H
H	A	E	E	D	E	I
D	G	H	D	G	I	A
B	I	D	A	C	A	B
G	D	I	B	I	G	F
E	F	B	I	A	B	C
C	C	F	H	B	C	G
A	E	A	F	H	F	C
F	H	C	C	E	D	D
0.046 to 0.0609	4.47 to 18.84	232 to 4	1.25 to 1.5	0.844 to 0.875	478 to 568	514 to 616

The essential features in the cost of cylinder lubrication can all be included in the following items: (1) The cost of the oil; (2) cost of repairs and lost power due to wear and friction; (3) cost of repairs due to the chemical action of the oil, after exposed to heat and pressure in the engine cylinder.

The first of these is, of course, the easiest to investigate. The second is considerably more difficult, as most tests for friction coefficients are not made under conditions existing in the engine cylinder, and are therefore practically useless. Some efforts have been made to reproduce the actual temperature, pressure, piston speed, rate of oil feed, velocity of steam, etc., in making these friction tests. Mr. Flowers' apparatus meets some of these conditions, and the bulletin of Mr. Weinbach gives results under varying conditions. The results seem to be fairly accurate, since the points conform to very definite curves, which are distinct for the different conditions and are reproducible, thus eliminating to some extent the criticism of Mr. Carpenter in regard to viscosimeters; namely, that none has been devised that will give uniform results.

The results of the friction tests indicate that the importance of the friction coefficients of the various oils has probably been overrated. While friction is important, it is of most importance in preventing wear in the cylinder, for the *difference* in the cost of lost power computed from the difference in the coefficients of friction and the annual horsepower output of the average engine is almost negligible, and this second item would not appreciably influence the choice of oils unless the other features were about equal.

In a recent paper presented before the 1916 convention of the Missouri Public Utilities Association, Mr. Flowers assumes an 18&24x36-in. compound engine running at 89 r.p.m. and finds that the cost of oil will be about 1.5c. per hr. and the cost of friction loss about 0.25c. per hr. Thus while the cost of friction loss is comparatively low, the *difference* in the cost of this loss when using different brands of oil will be inappreciable. Mr. Flowers also explains that if the rate of oil feed is increased to save friction loss only, there will be a loss instead of a saving.

Possibly the third item, the chemical action of the used oil, is the most important and at the same time the most difficult to compute. Leading engineers are attaching more and more importance to the chemical composition of the cylinder oils. In his article Mr. Fairbanks mentions the development of acid corrosion when only tallow oil was used in the steam cylinder of an air-brake. Mr. Carpenter also calls attention to the fact that the use of tallow on driver brakes was stopped on account of the chemical action. Investigation of some of the railroad specifications for cylinder oil indicates that they are permitting only a low percentage of animal fats. This usually decreases the cost, for the reason that good acidless tallow costs more than the mineral base and poorer fats should be left out anyway.

The question is of even more importance where feed water is heated in an open heater by exhaust steam and pumped into boilers where the acid content, or the acid formed from the breaking up of the animal and vegetable fats under the high temperatures and pressures, can actively attack the metal and cause corrosion, though it would be impossible to tell how much corrosion is due to such a cause. The so-called "gum" in engine cylinders has sometimes been found to be a sort of "iron soap." Under these circumstances the tests for acidity, the iodine number and saponification number assume special importance. These points are rarely touched upon by the salesmen. With these covered, however, by the specifications, and with the small importance of the difference in friction, the choice of oil will largely depend upon the observation and judgment of the operating engineer if he can be depended upon.

As Mr. Fairbanks aptly put it, "After we have all the facts, we will get back to what has been already demonstrated by practical operation."

In this connection I have noticed that the recommendations of a good oil man are valuable. After I thought I had the oil question well in hand, I found my ideas would not apply when later I had charge of a large number of low-pressure heating and ventilating plants. It was then that a good oil salesman of considerable experience was able to select a base and components that would fit the condition.

In the specifications for oil for this low-pressure work, we inserted the following items: Not exceeding 2 per cent. of pure acidless tallow; specific gravity at 60 deg. F., between 26 deg. and 29 deg. Bé.; flash point, not under 525 deg. F. (open); fire test, not under 600 deg. F. (open); viscosity at 212 deg. F., 130 sec. to 220 sec., Tagliabue; cold test, must flow at 40 deg. F. You will notice that there was a wide liberty allowed in the matter of the viscosity. I noticed from curves by the authorities mentioned herein that oils having viscosities between the foregoing limits at 212 deg. F. became about of the same viscosity at the temperature at which they would be used, hence the specification. I was not disappointed in the performance of the oil meeting this specification.

Like Mr. Carpenter, I think there is much "humbug" in the treatment of the oil question and would like to hear from other readers of *Power*. It would be interesting if someone would compile and compare the specifications of various users. The letter in the issue of May 23, from John L. Allen, in regard to graphite cylinder lubrication deserves careful consideration.

[*Power* will be glad to publish specifications of cylinder oil users.—Editor.]

Some writers answering Mr. Carpenter's letter state that viscosity is one necessary item in an oil specification. Unless the viscosity figure as usually determined has some reference to the viscosity at working temperatures and pressures, it is irrelevant and not necessary in an adequate specification.

J. A. WHITLOW.

Jefferson City, Mo.

Lifting Flanged Valve Bonnets

Flanged valve bonnets may sometimes be lifted without the use of wedges or chisels (which mar the gasket faces and spoil the gasket) by screwing down on the stem the same as in closing the valve. The action is the same as if the stem were actually a jackscrew lifting the bonnet with the same force.

Judgment of course must be exercised to avoid using too much force and injuring the threads.

Lodi, N. J. JAMES D. ZITO.

Fitting Corliss Valves

To those interested in the discussion concerning fitting Corliss valves (*Power*, Sept. 5, p. 363 and Oct. 3, p. 495), it may not be known that the original valves designed by Mr. Corliss were cast with a lug on the end on the side opposite the steam port and the adjacent portion was $\frac{1}{4}$ in. smaller than the valve chamber.

This lug was about 1 in. square and was used for a calipering surface. The valve was first turned to $\frac{1}{64}$ in. of size and then ground to size. This calipering lug was then chipped off so that the valve was free to lift from its seat, like a flat-slide valve would, in case of water in the cylinder. The valves made in those days had slots in which the end of the stem was fitted, and coil springs in holes held the valves to their seats. With the low-pressure steam and slow rotative speed these valves worked very well, but with high pressure and high speed they would chatter and rattle; therefore the design was changed so that the ends of the valve filled the hole neatly, the better to hold it steady. But it was always intended that they should be relieved on the back and not turned smaller than the bore.

Torrington, Conn. W. E. HOPKINS.

The Lubrication of Poppet-Valve Engines

I have read with interest an item in *Power* of Oct. 17, page 571, in which is quoted the experience with one of our engines at the Rockwell Manufacturing Co.'s plant in Milwaukee. As to the claim that their cylinder-oil consumption record surpasses all previous records of economic cylinder lubrication, I would say that this is not strictly a fact, as there are many vertical engines operated without any cylinder lubrication whatsoever, particularly marine engines.

The experience at the Rockwell Manufacturing Co.'s plant shows the advantage of the use of poppet valves and of carrying the weight of the piston on outside guides instead of on the bottom of the cylinder. In a Corliss engine of the usual construction, most of the cylinder lubrication is required for the valves and for providing a film of oil under the piston, as the weight of piston in this type of engine is carried on the bottom of the cylinder. The poppet valve has no rubbing surfaces, and thus there are no parts that require lubrication. If in addition, like in the Rockwell engine, the piston is turned smaller than the cylinder and supported on a stiff piston rod with a crosshead at either end, then there are no other surfaces to lubricate in the cylinder than the packing rings.

The nature and amount of friction of packing rings on cylinder walls is a matter that is difficult to observe and determine, therefore there are no reliable data on this point. The friction, however, on a well-designed packing ring is exceedingly small. If it were not, then it would not be possible to run some engines without cylinder lubrication. It is probable that a film of steam forms between the packing rings and the cylinder wall, which aids the lubrication.

In a Corliss engine we have to deal with unbalanced valves, and most of the cylinder lubricant is required to keep these valves from cutting.

The lubrication of a steam cylinder is of an entirely different nature from the lubrication of a bearing. In a bearing arrangements can be provided where the friction is reduced to a minimum; in fact, arrangements can be made whereby the shaft actually floats on a film of lubricating oil. This condition could not be even approached in the lubrication of steam cylinders, and I do not believe that the friction of a steam engine can be in any way reduced by increasing the amount of cylinder lubrication.

If the friction of the piston in a steam engine is not kept very low, this fact will manifest itself in wear and in the cutting of the cylinder; and as long as the amount of lubricant is sufficient to prevent cutting and wear on the cylinder, it is sufficient. As far as the cylinder of the Rockwell engine goes, there is no sign of wear.

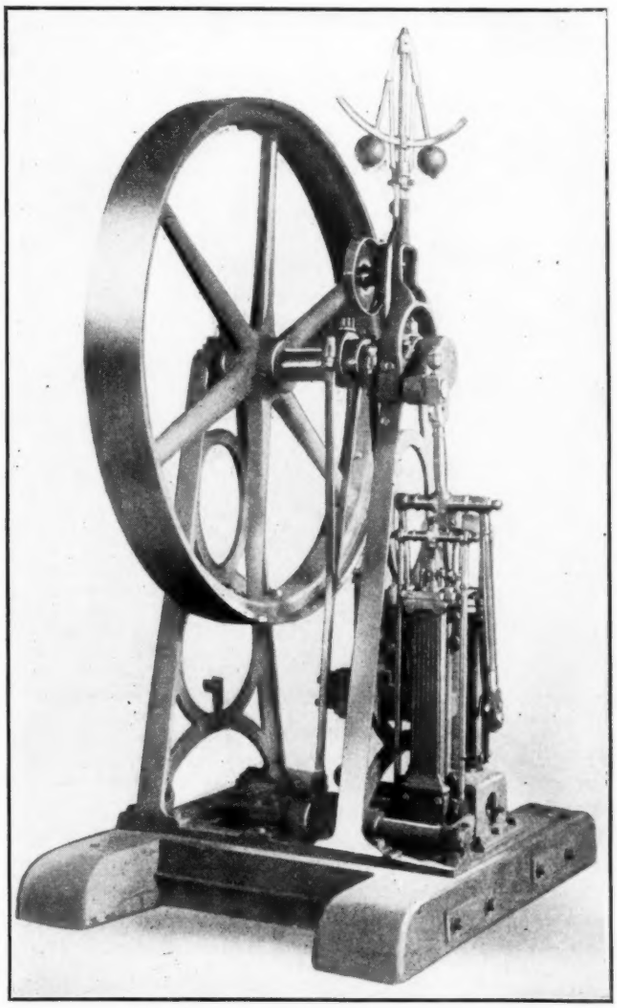
In many plants where city water is used for boiler feed and where the exhaust steam from the engine is used for heating purposes, a considerable portion of the feed water is used over and over again, and in such cases it is very important to minimize the amount of cylinder lubrication. BRUNO V. NORDBERG,

Chief Engineer, Nordberg Manufacturing Co.

An Early American Engine

The name of Baldwin is associated in the minds of engineers with the American locomotive, since Matthias W. Baldwin established his locomotive-building plant in Philadelphia in 1831. Comparatively few are aware of the fact that Mr. Baldwin started out in business as a jeweler and later took up the manufacture of bookbinders' tools and cylinders for printing calico. It was while engaged in this line of work about the year 1825 that his attention was turned in the direction that eventually led to his engaging in the construction of locomotives. His small establishment on Minor St. below Sixth was so successful that he decided to purchase a steam engine to operate the plant, as the business had even then outgrown the capacity of hand-operated machines. An engine was accordingly purchased, but proving unsatisfactory, he decided to design and build one himself to meet the peculiar requirements of his own shop, the foremost of which was that the engine should be as compact as possible. The exact date of the completion of this engine is uncertain, but it is known to be previous to 1830. Its performance was so satisfactory that a number of others were built for outside parties, all of them having been constructed before the building of his first locomotive, work on which was started in 1831. The original engine did service in different departments of the Baldwin Locomotive Works for many years and was used in the present plant until a comparatively recent date. Although not now in active use, it is still in serviceable condition and could do good work if required.

A general idea of the unique design of the engine may be obtained from the photograph. It is of the vertical type with the shaft above the cylinder, similar in this respect to others of the early days sometimes called "inverted engines." On an iron bedplate about 40x56 in., two cast-iron standards are mounted supporting the mainshaft, the center of the shaft being 6 ft. above the top of the bedplate. The vertical cylinder is double-



THE FIRST ENGINE BUILT BY BALDWIN

acting, with a diameter of about 6 and a stroke of 20 in. The piston rod, 1¼ in. diameter, works through the upper cylinder head and is connected to the middle portion of an inverted U-shaped forging 1½x1⅝ in., the ends of which project downward on each side of the cylinder. The lower end of each leg is formed into a crosshead block sliding between guide bars fastened to the sides of the cylinder at each end by studs. Attached to these blocks is the lower end of a forked connecting-rod, the upper, single end of which is connected to the crank in the usual way. The lower arms of the rod are 1½ and the upper arm 2 in. diameter, and the total length is about 40 in. Both ends of the rod are provided with keys and straps for adjustment.

The cylinder is mounted on what may be called an exhaust box 13x13x8 in., as shown in the illustration, into which the engine exhausts and to which the exhaust pipe is connected.

The steam distribution is controlled by a very long slide valve driven from a horizontal rockshaft, the latter being connected by a long rod to an eccentric. The arm on the rockshaft is slotted so that the pin on which the lower end of the eccentric rod works may be moved toward or away from the center of the rockshaft, regulating the travel of the valve, the position of the pin being controlled by a setscrew. The adjustment of the point of cutoff was apparently fixed to suit the work to be done.

The speed of the engine is controlled by a heavy pendulum governor mounted on one of the vertical standards and driven by a short belt and connected by a long rod to a valve in the steam pipe.

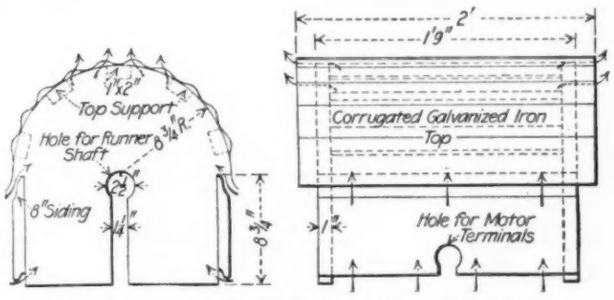
The mainshaft is 5¼ in. diameter, and on it is carried the flywheel, 83½ in. diameter with a 9½-in. face. The wheel has six arms and a rim 2¾x6 in. cast in sections, one to each arm, probably to allow for uneven contraction when casting. Around this rim there is a band 1x9½ in., which was probably shrunk on and also secured by 12 studs. The wheel is held on the shaft by a large setscrew and a key, or more properly, a lug, about ⅜x⅞ in. integral with the shaft and fitting into a keyway in the hub of the wheel. The hub is about 8½ in. diameter by 9½ in. long. The finish of the engine is excellent, particularly that of the working parts, which are turned and beautifully polished. The castings are also remarkably clean and accurate considering the early date of construction.

The engine represents an ingenious solution of the difficulty of securing a machine that would occupy the least amount of space and headroom while retaining the long stroke and low rotative speed of those early days of steam engineering.

HUGH G. BOUTELL.
Germantown, Philadelphia, Penn.

A Ventilated Motor Housing

In wet places the danger of water being thrown on the motors is very common, especially where direct-connected to pumps. In the mill of the Aurora Consolidated Mines Co. we had a 5-hp. motor direct-connected to a sump



END AND SIDE VIEW OF MOTOR HOUSING

pump. It was not an uncommon thing for the motor to receive a bath of slime and water; consequently, frequent burnouts occurred, so I designed and built a housing, as illustrated, to cover the motor.

The housing was made so as to be as compact and light in weight as possible and at the same time to ventilate the motor well. Ordinary house siding was used for the sides, raised about 0.75 in. above the base to give entrance to air, and the volutes of the corrugated galvanized-iron roof were used to give exit to the ventilating current.

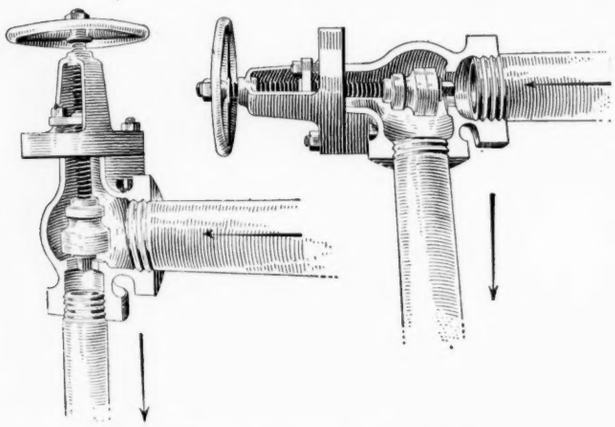
Air can also pass in under the lower edges of the roof. The arrows show the direction of the ventilating currents. Tests were made for temperature rise within the motor housing, and a variation of only 1 deg. C. was found between the inside and outside temperatures.

The housing is light and can be lifted up very readily to allow oiling of bearings and inspection of motor parts.

Denver, Colo. ARTHUR C. DAMAN.

Defective Blowoff Valve

I have had trouble with defective blowoff valves similar to that of which Mr. Conklin tells in the issue of Sept. 12, page 394, and will give my experience in correcting



POSITION OF VALVE REVERSED

the difficulty. The valve is on a 2-in. blowoff and carries 100 lb. pressure. The opening through the disk is only about one inch, and this opening is easily clogged by scale when the disk comes loose from the stem and causes considerable work and trouble to empty the boiler. As intended to be used, the valve stem stands in a vertical position, but by reversing or connecting it so that the boiler pressure will come under the disk instead of above it, I have eliminated the trouble. I found the studs broken or lost several times before I reversed the valve, but have had no trouble since. A. W. WILSON.

Sterling, Ill.

Testing Feed Water for Salt

It is a well-known fact that feed water for boilers should be as pure as possible and that excessive salts, alkali, etc., produce a dangerous hard scale. Most of the power stations in the vicinity of New York City use river water for surface condensers, and it contains considerable salt and other impurities. Small quantities of this cooling water get into the vacuum space and mix with the condensed steam and in this way into the boilers, so there is always considerable salt in the feed water.

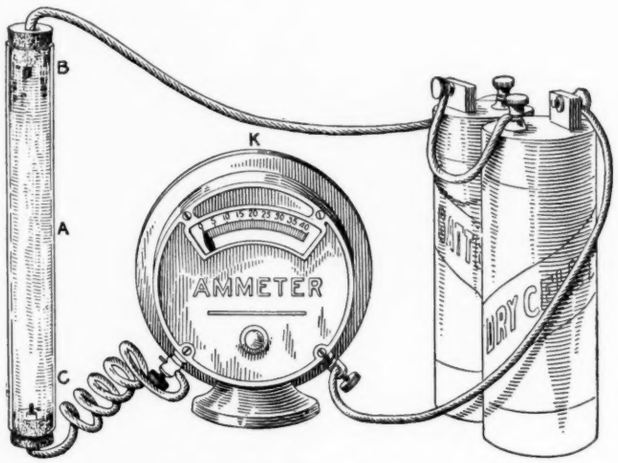
The usual test for salt (chlorine) in water is performed by adding two or three drops of potassium chromate solution (K_2CrO_4) to a sample of water and then titrating with a standard solution of silver nitrate ($AgNO_3$), but such a test requires laboratory experience.

A method, requiring no skill or laboratory experience, based on the electric conductivity of the water, is simple and less costly.

As the electrical conductivity of any sample of water depends almost entirely upon the substance dissolved in it and is directly proportional to the salt contained, this principle was applied by me in designing the device shown in the illustration.

The test is performed as follows: A sample of water is poured into a glass tube *A* having terminals *B* and *C* connected through an ammeter *K* with one or two dry cells *D*.

The voltmeter or ammeter *K* is graduated and marked so that the readings will indicate the actual percentage of salt in the sample of water. Electrolysis occurs when a current passes through the water between *B* and *C* and



SALINITY TESTING OUTFIT

causes the needle of the meter to go back slowly after reaching the maximum deflection; therefore it is advisable to graduate the scale of the meter by the maximum deflection of the needle. The electrolysis could be easily eliminated by another device, but this would make the apparatus more complicated.

The samples of water should always be of the same temperature because the conductivity varies with the temperature. Numerous tests have been made with this apparatus, with highly satisfactory results, and it may be used aboardship in place of the salinometer pot.

New York City. HENRY WYGOD.

To Remove Paint from Iron, a paint softener made of 1 lb. of lime to 4 lb. of potash mixed with six quarts of water will have the desired effect as quickly as many more costly preparations.—"Mechanical World."

Vibration of a Turbo-Generator by Resonance — Every structure has a natural period of vibration whose rate in general terms is dependent upon its elastic properties and its mass. Subjected to periodic impulses of the same rate, the structure will vibrate in unison with them, resulting in objectionable and, when the elastic conditions are favorable, dangerous oscillations. A case of this kind is reported in the Russian periodical, "Vestnik Ingenerov." A turbo-generator attached to a structural steel floor supported by steel columns, when running at its normal speed of 3,000 r.p.m., caused such serious oscillations of the structure that it was found impossible to operate the unit. A remedy was found in elastically supporting the bearings of the rotating members. So supported, the rotating parts have a period of natural vibration which is no longer coincident with the rotational impulses, and the action of the spring supports reduces the magnitude of the impulses received by the structure as a whole to such an extent that their effects are extinguished by the damping properties of the structure.—J. Vicenaif. ("La Revue Electrique," Vol. XXIV, No. 283, Oct. 1, 1915.)

Inquiries of General Interest

Stay Tubes for Fire-Tube Boilers—What is the purpose of stay tubes in a fire-tube boiler, and how are they made and inserted? F. B. F.

When expanding and beading the ends of the tubes cannot be depended upon for safely staying the tube-sheet, extra staying power is obtained for a number of the tubes, appropriately located, by providing tubes with upset ends, and these have outside screw threads that are screwed through tapped tube holes in the flue sheets. For inserting the tubes it is necessary to have the pitch of the screw threads continuous in both of the tube sheets. A check nut usually is placed on each end of the stay tube outside of the flue sheets, or the ends of the tube are expanded and beaded.

Why Firebrick Should Be Kept Under Cover—Why should new firebrick be kept under cover from the weather? A. G. W.

When the firebrick of a furnace lining contains moisture, it crumbles and spawls from the action of high furnace temperatures in rapidly driving off the moisture. If before being laid the brick has been exposed to wet weather, any moisture then absorbed requires a long time for its removal at the ordinary temperature of the atmosphere or temperatures low enough to be harmless. Hence for use within a reasonable time after being laid, firebrick should be carefully protected from the weather while held in stock.

Use of Automatic Glass-Gage Valves—What is the objection to the use of automatic valves for glass-gage connections for shutting off water and steam when the glass breaks? R. G.

Automatic shutoff valves for water-glass connections are objectionable because they may become inoperative from scale deposits that would close the connection and thereby falsely indicate the water level in the boiler. For most practical purposes, and without danger to the boiler attendant, the prolonged discharge of steam and water in case of breakage of the gage-glass can be prevented by employing a quick-closing type of stop valve conveniently operated from the boiler-room floor level by means of chains attached to the valve stem.

Power of Compound Engine Referred to L.-P. Cylinder—Having a 16 and 32x42-in. compound engine running 100 r.p.m. with 60 lb. m.e.p. in the high-pressure cylinder and 14 lb. m.e.p. in the low-pressure cylinder, how is the power computed by referring the m.e.p. of both cylinders to the low-pressure cylinder? J. M. C.

With the same stroke in each cylinder, the cylinder ratio will be the area of 16 in. diameter to the area of 32 in. diameter, and as the areas of circles are to each other as the squares of their diameters, the cylinder ratio will be as 16×16 to 32×32, or as 1 to 4. Hence each pound m.e.p. of the high-pressure cylinder would be equivalent to ¼ lb. m.e.p. in the low-pressure cylinder and with the m.e.p. of both cylinders referred to the low-pressure cylinder, the power developed would be

$$\frac{(60 + 14) \times (32 \times 32 \times 0.7854) \times \frac{1}{4} \times 100 \times 2}{33{,}000} = 494.73 \text{ i.hp.}$$

Horsepower Rating of Automobile Engines—What is the rule for rating the horsepower of automobile gasoline engines? T. W. M.

The formula for the horsepower rating of automobile gasoline engines that was adopted by the American Licensed Automobile Manufacturers' Association is

$$\text{B.hp. (per cylinder)} = \frac{D^2}{2\frac{1}{2}}, \text{ or } 0.4\ D^2$$

in which D = the diameter of the cylinder in inches.

This rating was intended for full-load conditions, assuming a piston speed of 1,000 r.p.m. and m.e.p. of about 80 lb. per sq.in. of piston or, more exactly, 78.9 lb. m.e.p. Although the formula given is still adhered to in rating the power of automobiles by most of the state licensing bureaus, the smaller diameters of pistons and longer strokes with accompanying higher piston speeds employed for more modern automobile engines make their horsepower rating by the old formula considerably lower than the power actually developed.

Gravity Return for 1-In. Pipe Coils—Our laundry drying-room coils made of 1-in. pipe with ¾-in. supply are located about 5 ft. above the boiler, which supplies the coils with steam at 85 lb. pressure. At present the coils discharge to the sewer. How can they be made to return the condensate to the boiler by gravity? G. A. M.

For a gravity return, the pressure at the point where the condensate leaves a coil, together with the head of water in the return pipe, must be sufficient to overcome the friction of the return pipe and fittings and the pressure in the boiler. With the coils 5 ft. above the boiler and allowing the boiler-water level to be 1 ft. below the top of the boiler, the head of water in the return pipe would amount to about $6 \times 0.433 = 2.59$ lb. per sq.in. Hence to obtain a return by gravity, without allowing for loss of pressure from pipe friction the pressure at the discharge end of the coils would have to be $85 - 2.59 = 82.5$ lb. per sq.in.

To maintain the necessary pressure at the discharge end of a 1-in. pipe coil less than 75 ft. long and constructed with headers, the diameter of the live-steam inlet in inches should be made equal to about the square root of $^1/_{34}$ of the number of feet of 1-in. pipe in the coils. A ¾-in. connection would be suitable for a pipe coil containing only about 19 ft. of 1-in. pipe.

Allen or Trick Valve—What is the difference between an Allen or Trick Valve and the ordinary D slide valve? T. W. M.

The Allen or Trick Valve differs from the ordinary D slide valve in having a passage P, as shown in Figs. 1 and 2. When the valve is just opening for admission of steam at one end, as shown in Fig. 2, the usual method of supply is supplemented by an additional supply that is introduced into the port through the passage P, which occurs when the edge G overrides the edge of the valve seat. Steam is thus admitted with double the area of port opening that could be obtained

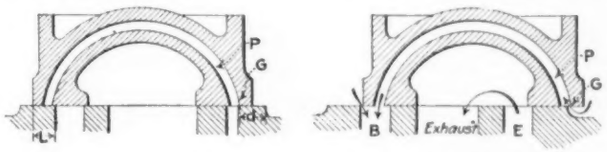


Fig. 1. Mid-position Fig. 2. Admitting Steam

SECTIONAL VIEWS OF ALLEN OR TRICK VALVE

for the same movement of the ordinary D valve and same length of port. In order that the outside edge of the valve and passage P may open simultaneously, the distance d, Fig. 1, from the edge G of the passage to the edge of the valve seat must be equal to the steam lap L. Fig. 2 shows the valve moved to the right far enough for the beginning of admission of steam to the cylinder passage B, and exhaust taking place from the cylinder passage E as with an ordinary D slide valve.

Efficiency of Air Compressor When Hot—Why is the efficiency of an air compressor less if it is hot? T. J. S.

Air at any given pressure occupies a greater volume for an increase of temperature, and the pressure of a given volume is increased for an increase of the temperature. With a hot compressor the volumetric efficiency is less, for the free air as it is drawn into the compressor cylinder has its temperature increased and consequently a less quantity or weight of air at atmospheric pressure can be admitted per suction stroke. The work of compression adds heat to the air, and the increase of temperature causes the release pressure to be reached earlier in the stroke and less heat is abstracted by a hot cylinder than by one that is kept cool. This would be no detriment to efficiency if the compressed air were to be used at the temperature attained in the process of compression. But for most practical purposes the air after leaving the compressor is allowed to stand or become cooled or is intentionally cooled to nearly the temperature at which it was drawn into the compressor. Such cooling is attended by a drop of pressure and waste of energy, for the higher the discharge temperature above the temperature at which the air is utilized the higher must be the pressure and the greater the amount of work required to compress a given quantity or weight of air to the pressure and temperature at which it is to be used. Hence, for ordinary uses of compressed air the hotter the compressor the lower its efficiency, because less quantity or weight of air is handled and more power is required to effect a given number of compressions.

A. I. E. E. Philadelphia Meeting

During the afternoon and evening of Oct. 13 in the Clover Room of the Bellevue-Stratford Hotel, Philadelphia, Penn., the American Institute of Electrical Engineers held its 325th meeting under the auspices of the Philadelphia Section and the Power Station Committee of the A. I. E. E. The meeting was one of the most successful ever held by the institute, over 400 members registering, more than 100 of whom were from out of town. It was the first attempt at holding a regular monthly meeting of the institute outside of New York City—as H. W. Buck, the president of the institute expressed it, an experiment, but the results justified the continuance of the practice.

The afternoon session opened with Mr. Buck in the chair. In his opening address he pointed out the significance of the turbine being the first conception of using steam for power, but this first conception was entirely lost sight of in the development of the steam engine until a few years ago, when we returned to the turbine, our first starting point. The same is true of the alternating-current system. The first alternating-current systems were single-phase, but the idea was almost lost sight of in the development of the polyphase system. Similar to the turbine, we find ourselves coming back to our first starting point and are assembled here today to consider the single-phase system.

F. L. Hutchinson, secretary, read a message of welcome from the Philadelphia Section to the visiting members and stated that the members of the Philadelphia Section were a committee to entertain the visiting members.

SUPPLY OF LARGE SINGLE-PHASE LOADS

The first paper presented at the afternoon session, "The Power Company's Problem in the Electric Supply for Large Single-Phase Loads," was read by W. C. L. Eglin, chief engineer of the Philadelphia Electric Co. The author took the position that the power company should be able to supply electric power for all the needs in the community, whether for industrial, street-railway or trunk-railroad use. The power company must also be able to supply power of uniform pressure, whether single-phase, two-phase or three-phase, at whatever voltage best suits the customer. It was pointed out that it is practically universal in large power companies to have the main generating stations equipped to generate polyphase alternating currents at high voltages and at frequencies of either 25 or 60 cycles.

The power companies' business in the early periods was electric lighting, but this had a very poor load factor even when combined with the power needs of stores and factories in the community. The most logical step to increase the load factor was to supply all the power needs of the community including the furnishing of power to large industries, street railways and steam railways in the central station's territory.

The generating apparatus must be capable of delivering power of uniform pressure irrespective of the demands, let it be single-phase, two-phase or three-phase current, at any voltage best suited to the customer's individual requirement. These conditions are best met by polyphase generating units, and on account of the economy in transmission three-phase units are being used universally.

With a balance two- or three-phase load to the customer, the problem offered no very great difficulties, but when a large single-phase load is required that cannot be balanced by other customers, new problems are encountered. The capacity of the generating units is reduced and the voltage of the system thrown out of balance. This can be partly overcome by placing a copper structure in the alternator's pole faces similar to that on the rotor of the squirrel-cage induction motor; second, by the use of external machines connected to the generator similar to a three-phase induction motor or by the addition of a booster on each phase; third, by means of a synchronous phase balancer, which consists of a two-unit machine. The function of one unit is principally to transfer energy between the phases; the other is a boosting set with two sets of field poles in the same field frame, one displaced 90 electrical degrees from the other, which balances the voltage of the different phases. The fields of the machine may be controlled automatically and the voltage of the system maintained balanced over a wide variation of load. It was about the synchronous phase balancer that the interest of the session was centered. Mr. Eglin announced that two of these machines had been installed and were in operation in the plant of the Philadelphia Electric Co. and that guides had been furnished to conduct any members who wished to visit the plant and see these machines in operation.

These phase balancers are to take care of the unbalanced single-phase railway load which this company is supplying. The machines are 5,000 kv.-a. capacity each, continuous rating, 6,000 kv.-a. for one hour, and 12,000 kv.-a. for five minutes. Mr. Eglin reported that the machines had already taken care of 20,000-kv.-a. single-phase peaks in the load.

The author also advocated that the central stations should insist that the power factor of the load be kept practically at unity. If this were possible he pointed out, the troubles of the central stations, as far as taking care of the great diversity of load, would be practically cut in two.

Philip Torchio, chief engineer of the United Electric Light and Power Co., New York, read the second paper of the afternoon session, entitled "Supply of Single-Phase Loads from Central Stations." He pointed out that contrary to the practice in Europe central stations in this country have extensively adopted single-phase distribution from polyphase stations, balancing the loads among the different phases by grouping of the single-phase feeders or the distributing substations. Voltage regulation for lighting circuits has been supplemented by individual regulators. Generators with good single-phase characteristics were sometimes employed. In other cases generators were installed of larger kilovolt-ampere rating than the kilowatt capacity of the steam unit.

Large customers, using electric welding machines, electric furnaces, etc., assist the balancing by dividing their load between the two or three phases.

In cases of railroad companies' generating stations, the single-phase power is furnished from three-phase generators of special design. In cases of purchased power from central stations, different methods of supply may be available.

The paper also gave a brief outline of the different schemes that were available for supplying single-phase service to the western portion of the New Haven R.R. electrification by the New York lighting companies. Four propositions were considered. After giving consideration to each one, it was decided to use specially designed 25-cycle three-phase generators, which would be capable of giving the required single-phase load in addition to other 25-cycle load in the territory supplied by the station. Mr. Torchio stated that their method of supplying the single-phase load from polyphase generators had proved very satisfactory to both their customers and themselves. After a brief discussion of the papers, the meeting was adjourned, a large number of the members availing themselves of Mr. Eglin's invitation to see the synchronous phase balancers in operation.

An informal dinner was given in the Stratford Room of the Bellevue-Stratford at 6 p.m., which proved to be a very enjoyable feature of the meeting, 296 of the members attending.

SINGLE-PHASE POWER PRODUCTION

The evening session was opened at 8 o'clock with President H. W. Buck in the chair. By this time everybody had become very much interested in just how the synchronous phase balancer worked, as it was something new to most of the members present. E. F. W. Alexanderson, the one man who is responsible for the development of this machine, read the first paper, "Single-Phase Power Production." The paper was presented jointly by Mr. Alexanderson and G. H. Hill. Before reading the paper Mr. Alexanderson gave a few simple explanations which changed the members' doubts and speculations into a clear understanding of the fundamental principles of the synchronous phase balancer. The paper treated the different methods of supplying a single-phase load, the theory of the phase converter, the different types of phase converters and their applications. This paper will be abstracted and published in a later issue.

The fourth paper, "Single-Phase Power Service from Central Stations," was presented jointly by R. E. Gilman and C. Le G. Fortescue and was read by the latter. Its purpose was to outline several methods by which single-phase power may be supplied from polyphase lines and to discuss their advantages and disadvantages.

It was the conclusion of the authors that where the unbalanced load fluctuates between the different phases and is of sufficient magnitude to cause trouble, a phase balancer is clearly the proper solution of the problem.

When a single-phase load on one phase is to be supplied, the problem becomes one of relative economy and reliability in service of the balancer, as compared with the single-phase generator. The main machine of the balancer set must have the same polyphase output as the alternative single-phase machine and must be provided with dampers of equal rating; but it must also be capable of withstanding the more severe short-circuit conditions due to its balancing action. In the balancer there is very little torque on the shaft, and therefore

the mechanical design may be cheapened and the operating speed increased. It is doubtful, however, if the main machine of the balancer set can be made much cheaper than a single-phase machine of the same output.

The auxiliary machine will necessarily be costly on account of the double set of poles and the wide range of excitation required. Its exciters must be relatively large in capacity so as to provide rapid change in excitation from full positive to full negative. In addition there will be the control system, which is complicated and costly. It is questionable whether this portion of the balancer set can be made for much less cost than a motor for the equivalent single-phase machine.

From an operating standpoint there is much to be said in favor of single-phase generation. In the first place, it is isolated to a large extent, or if steam-driven, completely, from the main polyphase system. This is of distinct advantage if the single-phase load is subject to frequent and violent interruptions. In the second place, the short-circuit condition resulting from the use of the single-phase machine will be, in general, much less severe and therefore less apt to cause trouble and prolonged interruptions in service than when a balancer is used.

From the viewpoint of economy of operation, there is little to be said in favor of one over the other; the balance is probably in favor of the phase balancer when compared with the motor-generator set and in favor of the generator when it is steam-driven.

After the reading of the papers Mr. Buck remarked that the members of the institute were fortunate to have them presented in English and not in symbols and that in the future the institute's literature could be enriched by many such presentations.

During the discussion of the various papers, many suggestions were made as to standardizing the frequency, improving the power factor of the system and supplying single-phase loads from a three-phase system, after which B. A. Behrend enumerated some of the difficulties that were now confronting the electrical engineer in the design of high-speed alternators and other types of alternating-current apparatus.

He asserted that it was impossible to design a 60-cycle series railway motor and therefore all alternating-current series motors for railway work must operate from a 25-cycle circuit. In summing up the various suggestions, he said that it would be interesting to know how to design a system to supply a low-voltage 25-cycle single-phase railway load from a high-voltage 60-cycle three-phase system and maintain the power factor at unity with the current and voltage in the three-phase system balanced.

Flow of Superheated Ammonia*

By Prof. Edward F. Miller

SYNOPSIS—Paper gives results of experiments on flow of superheated ammonia through pipes.

The tests[1] from which these data were compiled were undertaken to obtain sufficient facts on the flow of superheated ammonia in a pipe open to the air, from which, taking into account the length of the pipe, the necessary size of the discharge of a safety valve might be calculated.

The experiments were all made on Beyers pipe 1½ in. diameter. This pipe, in the first series of tests, was provided with tees and thermometer wells at intervals of 10 ft. for the first 30 ft., at intervals of 20 ft. for the next 40 ft. and 10 ft. for the last 30 ft. In the second series of tests there were tees for taking the pressure and temperature at entrance and at exit only.

The gas was supplied to the pipe by a 400-ton machine regulated to give the head pressure desired on an orifice ½ in. diameter, which was used to measure the weight of ammonia entering the 100 ft. length of experimental pipe. This orifice was mounted in 5-in. pipe. The pressure on the exit side of the orifice was the pressure entering the pipe. The first tee in the pipe at the beginning of the 100-ft. length was located 3 ft. beyond the 5-in. pipe and about 4½ ft. beyond the orifice.

The ammonia discharged from the end of the pipe was taken into the suction side of a 1,000-ton machine, which in turn was regulated as to speed, so as to keep the exit pressure as near atmospheric as possible. On account of conditions it was not possible to get more than a 24-lb. drop through the experimental line.

The thermometer wells used in the tees were 3 in. deep; the bottom of the well was kept above the straight opening through the 1½-in. pipe.

The orifice used for measuring the flow was ½ in. diameter, with the curve ¼ in. radius at entrance, the straight part of the orifice being ¾ in. long. The pressure in the orifice was obtained through an opening $\frac{1}{32}$ in. diameter, drilled at right angles to the straight part of the orifice. The quantity flowing through the orifice was determined by the method outlined in the "Journal" of the American Society of Refrigerating Engineers for November, 1915. ("Power," Dec. 21, 1915, pp. 871, 872, 873 and 874.)

Experiments were run with head pressure varying by 25 lb. from 50 lb. gage through 200 lb. gage, with pressures at entrance to the 1½-in. pipe varying from 31 lb. absolute to 67 lb. absolute and temperatures from 141 to 171 deg. F.

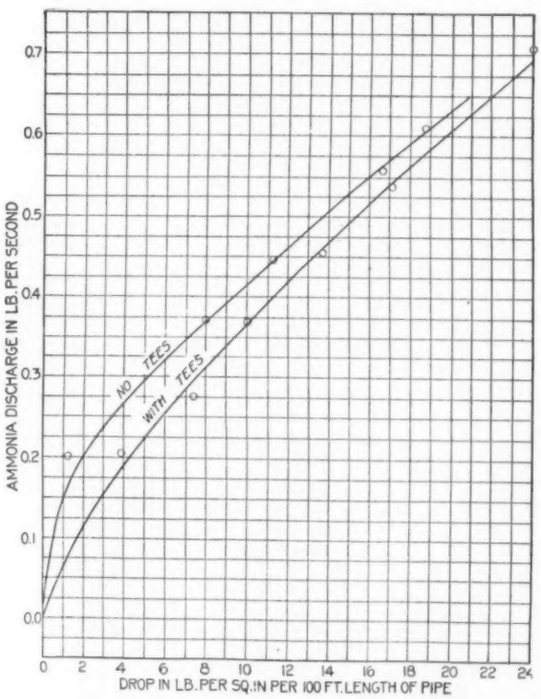
The curve gives the results in condensed form.

A formula deduced to fit these experiments on 1½-in. pipe with tees in the line was given as

$$W = 1.6D\left(\frac{100d}{L}\right)^{0.318}$$

where

D = Density at entrance;
d = Pressure drop in pounds for length L;
L = Length of pipe in feet;
W = Weight per second in pounds.



SHOW FLOW OF SUPERHEATED AMMONIA IN PIPES

It is probable that there will be but little error if this formula is put into the form that follows, so as to make it apply to pipes from 1 in. to 2 in. diameter:

$$W = 1.6D\left(\frac{100d}{L}\right)^{0.318}\frac{b^2}{2.25}$$

where b = diameter of pipe in inches.

The Babcock formula with constant deduced from these experiments becomes

*This paper gives in condensed form the results of an investigation made by Edward A. Whiting and Edward H. Williams, class of 1916, Massachusetts Institute of Technology, presented by them as their thesis and published in the "Journal" of the American Society of Refrigerating Engineers for October.

[1]Through the courtesy of F. L. Fairbanks it was possible to carry on these tests at the Quincy Cold Storage and Warehouse Co.'s plant at Eastern Ave., Boston, Mass.

$$W = 2.37\left(\frac{dDb^5}{\left(1+\frac{3.6}{b}\right)L}\right)^{\frac{1}{2}}$$

These formulas, if applied in figuring the discharge capacity of 100 ft. of pipe on the outlet of a safety valve having inlet and outlet pipes of the size called for by the refrigeration regulations in force in Massachusetts, show that in every case the pipe has a discharging capacity at least 50 per cent. greater than the rated capacity of the valve.

PERSONALS

G. B. Babcock, manager of the General Gas Light Co., at San Francisco, has been elected president of the Pacific Coast Gas Association.

A. McLellan has been appointed Canadian representative of the Nelson Valve Co. and Yarnall-Waring Co., with offices at 301 Read Building, Montreal.

A. H. Pohlman, formerly with the Brooklyn Union Gas Co., is now sales engineer in the Cincinnati district for the Combustion Appliances Co., of Chicago.

James F. Marshall, of Philadelphia, Penn., who for over 14 years has been doing consulting work, has accepted the position of chief engineer for the Hotel Traymore, Atlantic City, N. J.

John S. Carpenter, who has been hydaulic engineer with the Pelton Water Wheel Co. for the last eight years, is now designer of hydraulic power plants for the Fargo Engineering Co., of Jackson, Mich.

James G. Wray, formerly chief engineer of the Central Group, Bell Telephone Companies, of Chicago, is now associated with Hagenah & Erickson, public-utility engineers, First National Bank Building, Chicago.

Burt B. Brewster, for the past two years Alaska manager for the Sullivan Machinery Co., with headquarters at Juneau, has been transferred to manage the Salt Lake City branch office of the company, succeeding H. E. Moon, resigned. Walter F. O'Brien, who has been associated with Mr. Brewster at Juneau, will succeed him as local manager for Alaska.

Lyman B. Brainerd, who succeeded J. M. Allen as president of the Hartford Steam Boiler Inspection and Insurance Co. in 1904, died suddenly at 6:30 p.m. on Oct. 11. He was 60 years of age and had been apparently in perfect health.

ENGINEERING AFFAIRS

Bayonne Association, No. 7, N. A. S. E., of New Jersey held its inaugural entertainment and ball at the Opera House on Oct. 13. An enjoyable entertainment by "The Bunch" was followed by dancing.

The Mercer Council No. 50, Universal Craftsmen, will hold its next monthly meeting on Oct. 28 at Trenton, N. J. R. D. B. Wright, of the Harrison Safety Boiler Works, will speak on "Water Softening and V-Notch Meters."

The Association of Iron and Steel Electrical Engineers will hold its next regular monthly meeting in Pittsburgh on Nov. 18. David Wright will present a paper on "Variable-Speed Alternating-Current Motors for Mill Drive."

MISCELLANEOUS NEWS

The Detroit Board of Commerce has started a vigorous campaign to abate the smoke nuisance in that city.

Flywheel Explosion—On Oct. 12 a 30-ton flywheel exploded in the rolling mill at Newport, Ky., injuring one man and doing $25,000 damage to the plant. The accident is said to have been the result of overspeed caused by the governor failing on the engine.

Missouri & Southeastern Utilities Co., comprising electric-light and power plants at Caruthersville, Hayti and Kennett in Missouri and Blytheville, Rector and Piggott in Arkansas, has been sold to John H. Watkins, of New York. The sale was negotiated by Arthur D. Lord.

BUSINESS NOTES

The Ames Iron Works announces the removal of its Boston offices to Penn Mutual Building, 24 Milk St.

G. L. Simonds & Co., of Chicago, announce a change in name, the company to be known in future as the Vulcan Fuel Economy Co.

The Erie Engine Works, of Erie, Penn., announces the new location of its New York sales offices at 90 West St., sixth floor, under the management of W. B. Connor, Inc., who has been appointed general sales agent for this territory.

H. W. Johns-Manville Co. has just opened a new Branch Office at Great Falls, Mont., on the fourth floor of the Ford Building, Room 418, in charge of J. H. Roe. With the opening of the Great Falls office the company increases its number of branches to 55.

Stoker Exhibit—The George J. Hagan Co., 401 People's Bank Building, Pittsburgh, is undertaking an original and interesting propaganda in connection with the stoker which it handles. Appreciating the amount of time involved in making personal investigations of stokers at various installations around the country, the Hagan company has placed on exhibit, in a central location in the downtown district of Pittsburgh, a full-sized Type "E" stoker, which will be in operation during Pittsburgh Smoke Week, commencing Oct. 23, and probably longer. A cordial invitation is extended to everyone to pay this exhibit a visit.

Proposed Construction

Ariz., Wickenburn—City receiving bids October 30 for electric-light and power plant. H. P. Ward, town clerk.

B. C., Grand Forks—Council plans to extend electric-light plant.

B. C., Nelson—Directors Utica Mine plan to build power plant.

Calif., Alameda—Union Iron Works, San Francisco, granted permit for power house at shipbuilding plant at Alameda. About $22,500.

Fla., Plant City—The Plant City Public Service Co. has acquired the system of the Plant City Ice and Power Co. and will enlarge same. R. Nettles is secretary.

Ga., Dawsonville—Howser Bros. interested in installation of electric-lighting system in Dawsonville.

Ill., Arenzville—Arenzville Light and Power Co., recently incorporated with $10,000 capital stock, plans electric-light plant. J. C. Pratt interested.

Iowa, Brushy—Ft. Dodge, Des Moines & Southern R.R., Boone, plans substation at Brushy. P. O. Dunicombe, Ft. Dodge, chief engineer.

Iowa, Elkader—Schmidt Bros. & Co. plan to extend transmission lines from Elkader to St. Olaf and Farmersburg.

Iowa, Humboldt—Northern Iowa Gas and Electric Co. granted permission for transmission line in Wright County.

Iowa, Shanandoah—City election Nov. 7 to vote on bonds for electric-light plant.

Kan., Mullinville—City election Nov. 7 to vote on $10,000 electric-light plant bonds.

Kan., Neodesha—City receiving bids Oct. 30 for brick power house, about $10,000. J. J. Carroll, city clerk. Black & Veatch, Interstate Bldg., Kansas City, Mo., engineers.

Ky., Georgetown—City election Nov. 7 to vote on $100,000 bonds for electric-light plant.

Ky., Murray—City plans election in November to vote on bond isue for light and power plant.

La., Welsh—City plans election to vote on bonds for extending electric-light system.

Mass., Petersham—Town plans to install electric-lighting system.

Minn., Bethel—Eastern Minnesota Power Co., Pine City, granted franchise to install electric-lighting system in Bethel. J. M. Allen, Pine City, president.

Minn., Hibbing—Village soon to receive bids for one-story power station, about $200,000. Tyrie & Chapman, Auditorium Bldg., Minneapolis, architect.

Minn., Robbinsdale—Council plans to install electric-lighting system.

Miss., Durant—City plans to improve municipal electric-light plant. E. W. Weathers, superintendent.

Mo., Joplin—City plans election to vote on $175,000 bonds for light and power plant. J. F. Lee, Commissioner Public Property and Public Utilities.

Neb., Sterling—Sterling Light and Power Co. made preliminary surveys for 50-mile transmission lines. W. W. Marks, general manager.

Neb., Imperial—Citizens voted $15,000 bonds for hydro-electric-light and power plant. Grant & Fulton, Bankers' Life Bldg., Lincoln, engineer.

N. C., Pilot Mountain—Pilot Electric Co. granted franchise for electric-lighting system in Pilot Mountain. J. Hiatt interested.

Ohio, Cleveland—Schneider-Becker Dairy Co., 7100 Clarke Ave., making plans for power plant. W. D. McCormick, ninth floor, Century Bldg., Pittsburgh, architect.

Okla., Yale—City election soon to vote on $10,000 electric-light plant bonds. G. C. Dale interested.

Penn., Woodbury—Council plans to install electric-light plant.